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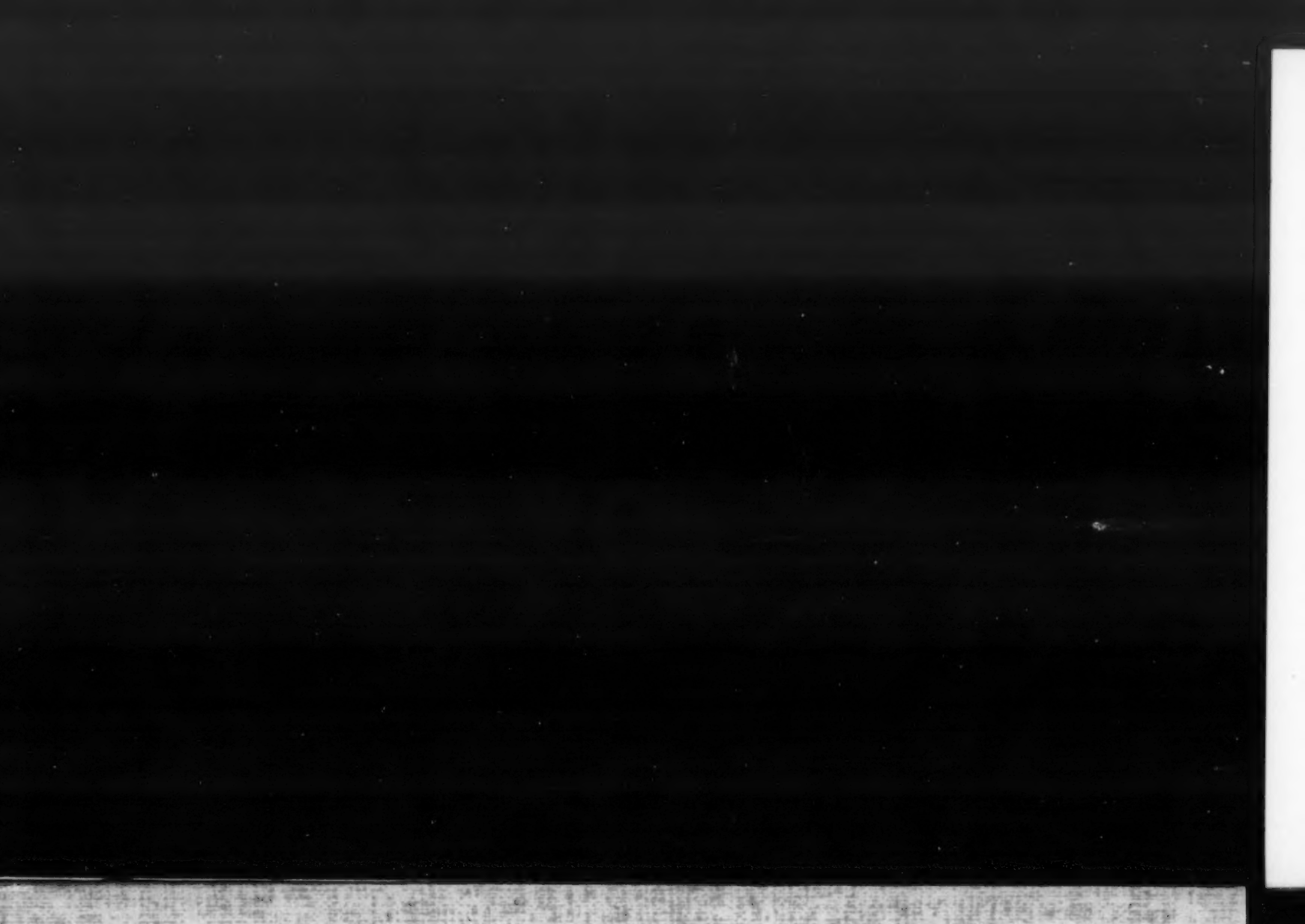

PRESIDENT'S ADDRESS

W. A. STOCKING, JR.

Delivered before the American Dairy Science Association

Springfield, Massachusetts, October, 1916

Mr. Chairman and Members of the Official Dairy Instructors' Association:

We meet today for our eleventh annual meeting (second session) since the organization of this Association in 1906. During the years that the Association has been in existence, much progress has been made in the methods of teaching dairy industry, in the development of scientific truths, and in their application to commercial dairy work. During this period conditions affecting the dairy industry have changed greatly and are still changing rapidly in many sections of the country. We still have many difficult problems to meet which will require the best talent available, both in our teaching and research work, and in our relations with commercial dairying.

It has been difficult for our departments to keep up with the demands placed upon them. The call for well trained men for teaching and research work has been strong, and has increased with the years. At the same time progress toward a higher grade of dairy products has developed the need in commercial work for men with good training in dairy chemistry and bacteriology. Commercial concerns are recognizing more and more the potential ability in young college graduates and the demand for them is increasing. Men with business foresight, recognizing the value of training, are taking our most promising graduates at salaries higher than can be paid by colleges and stations. Nor have they failed to recognize the commercial value of men with years of training and experience in actual teaching and research and are drawing men away from the colleges into commercial work, under financial inducements with which the colleges are not yet able to compete.

In many instances, this situation is resulting in our departments being forced to use men of second grade, to fill positions as assistants and instructors, and at the same time lose their older and stronger men—men whose experience and judgment is vital to the maintenance and development of the department's work.

This results in a critical situation, and I believe we must face squarely the question as to the future of the profession of teaching and research, in the field of dairy industry. With the strong call for men in commercial work, many of our best students fail to see the advantages of graduate training. Is this due simply to the allurement of commercial work with the prospect of a career of business activity or partly due to the attitude and vision of our dairy instruction. In business, so in teaching, it is a good thing to take an inventory occasionally and see just where we stand. In each State, the courses of instruction have developed gradually from rather small beginnings. As the work has developed, many new courses have been added, and I believe that we can feel just pride in the progress that has been made.

But it is easy to drift and I believe we should challenge our work and determine anew our relation to the industry which we represent.

Are we furnishing the kind and the quality of instruction which is needed? The work of a dairy department covers a broad field, involving as it does all questions pertaining to the development and care of the dairy herd; the production and handling of milk for direct consumption, and the manufacture of dairy products of various kinds. While in a general sense our industry is an applied one, it rests heavily upon several fundamental sciences including the principles of plant and animal growth, animal breeding and nutrition, physics, chemistry and bacteriology. The man who fits himself thoroughly for teaching and research in the general field of dairying must have a very broad foundation. This is very different from the man who is fitting himself for work in a single science, such as chemistry or entomology. When the men who are now prominent in dairy work received their college training, the bachelor's degree, or at the most, a master's degree was all that was considered necessary,

and it is probably safe to say that most of us feel our limitations because we did not have more training in one or more of the group of sciences mentioned. True, this is a day of specialists and specialization and the teacher is limited to a relatively narrow field of work. However, I believe the urgent demand both now and in the future will be for men with greater training, and the man who now contemplates entering our field of teaching or investigation should have at least the amount of training necessary for the Ph.D. degree. It is an encouraging sign that men with this kind of training are beginning to appear in our dairy departments.

A serious problem for us to consider is how we are to persuade our most able graduates that here is a field of work worthy of their continued study and best efforts. This raises at once the question of the type of graduate instruction which we are prepared to give.

With the development of the dairy industry the relative importance of the different branches of the work has changed. In the early days the problems of the greatest interest to the dairy farmer were those having to do with the development and maintenance of his herd. Now the average farmer is fairly familiar with the principles of breeding and of feeding and problems of quality of products and methods of marketing are of increasing importance, in fact, in many sections, are today the vital issues. In theory, it is very well to make two blades of grass grow where one grew before, or in the language of the dairymen, "make two quarts of milk flow where one flew before," but history has shown that increase in production may be accompanied by a decrease in profit to the producer. Unless the second blade of grass, or the second quart of milk, can be produced at a profit, its production is of no advantage to the farmer. Fifteen or twenty years ago butter and cheese represented the normal outlet for the farmer's milk, and this is still true in some sections where markets are far away, but in many sections today, the conditions have changed and the farmer's outlet is in the form of market milk for direct consumption, or in the production of some of the newer products, such as ice cream, fancy cheeses, con-

densed or powdered milk. These changes in commercial conditions require corresponding changes in our instruction and we should consider carefully whether or not we have developed our courses of instruction to meet this evolution, and are turning out men qualified for responsible positions in these lines of commercial work. This involves, in some cases, swinging the emphasis from the dairy cow to the handling of her products, and, while the cow is today no less important and no less interesting than formerly, we must recognize the increased importance of a thorough knowledge of the best methods of handling her products. Meeting the new situation in some cases may involve a reorganization of our courses of instruction. How many of our departments are now giving thorough courses in the handling of market milk, or the making of condensed or powdered milk?

In the field of research, our dairy departments have done much work of the greatest value and we are all indebted to many of our members for the results they have accomplished. A review of the literature will, I think, impress us with the fact that most of the best research work of our departments has been along lines relative to the development and care of the herd rather than the handling and disposition of the products. It is true that there are some notable exceptions to this statement, but I wish to raise the question as to whether the time has not now come when more of our departments should be devoting at least a part of their efforts to research work in connection with the handling and quality of our dairy products. Take, for example, the problems connected with production of milk of the sanitary quality now demanded by our cities and health officials. Who knows the conditions that are really essential for the production of milk of a specified germ content? You may say at once that these things have been established by the work of certain investigators, the quality of whose work is recognized and respected by all, but without casting the slightest reflection upon work already done, I wish to emphasize the importance and the necessity of duplication of research work by different men working independently and in widely separated regions. Our pres-

ent beliefs regarding the breeding and feeding of the dairy cow have not grown out of the results of one or even a half dozen able workers. Why should we draw equally important conclusions regarding essentials for the production of sanitary milk from the work of a smaller group, even though equally able men? I do not believe that duplication of research work is to be deplored or regarded as an unwise expenditure of University, State, or Federal funds, at least until we have far more information than is now available along the lines of sanitary milk production and the biology of dairy products, and until the work has been checked by a number of independent workers.

One of the perplexing problems of the dairy departments today is their relation to the farmer and our so-called extension work. I am sure no one fails to recognize the great value of this line of Dairy Instruction, and the fact that it is of great productive importance to our industry. But with the urgent and ever-increasing demand for this type of work, I fear there will frequently be a strong temptation for the Departments to so divide their energies that resident instruction to the regular students will suffer. The question of whether the men responsible for the teaching of regular students should also do extension work, and if so, to what extent, is a most important one. Certainly in our college teaching we do not want to lose touch with the man on the farm. Equally true it is that we do not want to model our university teaching after the type needed by the man on the farm, or the short course student. It is not an easy matter to keep the proper balance between these two types of instruction, and we should take great care that one does not develop at the expense of the other.

One of our difficult problems today is that of training the men who will stand responsible for dairy instruction in the future. Are we providing in our departments an atmosphere of study and research which will appeal to our best students? The opportunities in the field of dairying are large and justify their taking the necessary graduate study in preparation for this work. Until our colleges can meet the opportunities offered by commercial work, the great need of the industry is able teachers and

investigators who will enter this field of work with the clear understanding that they will not receive high or perhaps even adequate financial compensation, but that they are devoting themselves to the advancement of truth and the betterment of mankind.

ON THE FORMATION OF "EYES" IN EMMENTAL CHEESE[1]

WILLIAM MANSFIELD CLARK

From the Research Laboratories of the Dairy Division, Bureau of Animal Industry, United States Department of Agriculture

INTRODUCTION

The quality of a prime Emmental cheese is determined not alone by its sweet, nutty flavor and pliant texture, but also by the character of its holes.

Cracks, which frequently mar the appearance of a cheese, are intimately connected with a faulty texture. So too are the holes dependent upon proper texture for their shape; but, while the holes have a more or less spherical form as if distended by a gas in a plastic medium, there are important distinctions superficially based upon their size.

The normal "eyes," familiar to every lover of "Swiss cheese," vary from the size of a hazel nut to that of an English walnut. When uniform in size and distribution they give "The King of Cheeses" a distinction admired by the connoisseur. To quote the words of an authority (24) on the manufacture:

> Beim Anbohren entschlüpft dem Kenner ein bewunderndes "Ah," wenn sich auf dem Böhrling zwei bis drei mattglänzende, sauber ausgearbeitete Augen von ein bis zwei Centimeter Durchmesser zeigen.

On the other hand there frequently occur large "blow holes" which not only may mar the contour of a cheese, but which sometimes are associated with an "off flavor." Last and worst are "die Nissler," "the thousand eyes," the "pin holes," which frequently ruin a cheese by making it spongy, and which always detract from its commercial value even when present in small number.

There is also a marked difference in the times at which the various classes of holes develop. So many apparent anomalies

[1] Published by permission of the Secretary of Agriculture.

occur in cheese making that generalizations are dangerous, but, with a fair degree of truth, it may be said that "Nissler" holes develop while the cheese is under press or directly after; while normal eyes seldom start until the cheese is at least a week old. Again large holes seldom develop in press. They generally become evident later, and instances are noted by the European writers where they develop after normal eye formation.

Aside from the superficial distinction of size there are certain more fundamental differences of origin. Nissler holes undoubtedly have their origin in a gaseous fermentation of the sugar of fresh curd. Such a fermentation may be produced by bacteria or yeasts. When caused by bacteria the abnormal fermentation is revealed by the gaseous content of the holes, for it was shown by Clark (6) that the gas of Nissler holes may contain a large percentage of hydrogen, while that of normal eyes contains none. Various attempts have been made to distinguish the fermentations responsible for various types of holes. The greatest success has been met in the study of Nissler holes, for a number of bacteria and yeasts have been found whose gaseous fermentation of the sugar in fresh curd may clearly be held responsible. In like manner the formation of blow holes has been clearly traced in certain instances. The biological origin of normal eyes is still in doubt.

However, we are not now concerned with the bacterial origin of any of these openings, nor even with the texture of the cheese which is an essential prerequisite to their formation. The point to be discussed is merely the superficial distinction of size and its cause.

Granting that the distending gas in each case has its origin in a distinct fermentation, why should this superficial difference of size be so persistently characteristic? The time was when the different fermentations were far less clearly distinguished and the difference between pinholes, "eyes" and blow holes was considered to be merely one of size, and perhaps also of the period of cheese ripening in which they are formed. Baumann (2) made no other distinction than this and attributed the three general types of holes to the activities of the same organism.

Weigmann (33) adds:

Auf dem Gebiete der Käsegärung haben wir gefunden, das die Käseblähung in den meisten Fällen von gewöhnlichen Milchbakterien bezüglich Pilzen ausgeht und die normale Augenbildung und die Käseblähung physiologisch dasselbe sind und sich nur quantitativ unterscheiden.

We now know the distinction to be qualitative, but whether it is quantitative or qualitative the same question may fairly be asked: Why is it that gas holes formed "in press" are generally small and numerous while eyes which develop slowly are large and comparatively few?

If a well based reason for this shall be found, we may have gained a better view of the more general aspects of hole formation, and a firmer grasp upon the means of scientific control we hope to attain.

Aside from its intrinsic interest the determination of the factors which influence the size and spacing of the eyes is of direct practical importance inasmuch as there are evidence that preference is turning gradually toward a cheese with larger and fewer eyes.

In 1896 Bächler (1) described the ideal Emmental cheese as one having eyes 1 to 1.2 cm. diameter, 2 to 4 cm. apart. Peter and Held (24), in the 1910 edition of their text book, give the diameter as 1 to 2 cm.; as does Konradi (19) who visited the Swiss factories in the summer of 1912. Thus between 1896 and 1912 the maximum size of an ideal eye increased from 1.2 cm. to 2 cm.

Certainly the cheeses which sell as imported over the counters of our local markets are characterized by eyes fewer and larger than those described by the European writers; while the "domestic Swiss" have more and smaller eyes. Whether the European makers select cheeses with larger eyes expressly to meet the demands of the export trade; or whether there is a differentiation between all cheeses of domestic or foreign make, which if texture and flavor are equal, brands a small eyed cheese as "domestic" and a large eyed as "imported," it is difficult to say. Nor is it

essential to our purpose to discover, except insofar as the distinction in the market indicates a preference which the maker must meet.

In the following pages one very important factor in determining the size and spacing of holes will be presented.

THE RELATION BETWEEN BACTERIAL COLONIES AND EYES

It seems to have been assumed by many writers that, if bacterial action is the cause of the evolution of the gas, bacteria in sufficient numbers to produce this necessary gas must be strictly localized about a hole. This certainly is the most straightforward supposition to make; and, if true, it would seem as if a comparison of the flora about the eyes with the flora in other parts of the cheese would lead at once to the discovery of the organisms to which eye formation is due. Such comparisons have, however, not furnished the striking results we would expect.

That there does appear to be an unequal distribution of bacteria in hard cheeses is indicated by the investigations of several writers. Wigand (34) as early as 1884 stated that the bacteria in cheese are distributed in part as clusters. Inference of an unequal distribution was found by Duclaux (7) and by Troili-Petersson (31) in their observations that heavy inoculations from cheese sometimes gave no fermentation when smaller inoculations did.

Burri (5) describes a rare case in which dark colored colonies unassociated with "eyes" had become large enough to see.

Harrison and Connell (15) found a difference of 30 per cent in the bacterial content of different regions of Cheddar cheese.

In judging the value of the methods of study used in the investigations mentioned above it must not be forgotten that the transference of bacteria to artificial media for the purposes of counting and cultural tests is accompanied with the presentation to the bacteria of very different conditions from those found in cheese. None of the artificial media so far devised approximates exactly the relative great power of cheese to preserve a more or less constant hydrogen ion concentration with

the consequent extension of growth and the control of enzyme action. Nor do artificial conditions always simulate cheese in furnishing the proper degree of anaerobiosis. Thus an organism or its liberated enzymes may be able to produce in cheese much more CO_2 than in artificial media; and, as the limits of growth and action are reduced by artificial media, large differences in gas producing power may become narrowed to such an extent that the powers of different organisms may appear the same. It may therefore be true that some of the organisms isolated from certain regions, although culturally appearing identical in number and kind to those isolated from other parts of the cheese, may indeed have far greater CO_2 producing power when growing in cheese.

Jensen (18), upon comparing the number of bacteria on the walls of eyes and in parts of cheese distant from eyes found no striking difference. In fact a glance at Jensen's table shows that often the preponderanoe was in favor of regions of the cheese distant from the eyes.

But let us see what evidence direct microscopical observations present. Upon the unequal distribution of the bacteria, as seen in cheese sections, Beijerinck (3), Maggiora, (22) Troili-Petersson (30), Harrison, (14) and Percival and Mason (23) agree.

Gorini (13) determined the distribution of bacteria in Grana cheese by sectioning both fresh samples and samples hardened with alcohol. He found bacteria in enormous numbers and their distribution he grouped under two classes. The first class was that of dissemination, that is, a more or less uniform distribution of uncolonized organisms. In the second class were grouped the large colonies similar to those of plate cultures.

Rodella (25) supplemented the ordinary methods of histology by pressing cubes of cheese between two glass slides and staining the cheese which adhered to the glasses when they were withdrawn. He came to much the same conclusion regarding the distribution of bacteria.

The unequal distribution, as Gorini pointed out, should make us skeptical of "counts" as ordinarily made; not only because of the difficulty of obtaining a homogeneous sample with such

an imperfectly soluble substance as cheese, but because the bacteria are so unevenly distributed. This should add to the value of the direct microscopical methods, although Boekhout and Ott de Vries (4) have protested that the scattered bacteria found in sections may have been smeared off the colonies by the knife, and Troili-Petersson suspects that many of those seen are the borders of colonies on other sections. On the other hand Boekhout and Ott de Vries claim, that many of the colonies they observed in Edam sections were of dead bacteria, and consequently were not ripening centers. To this Löhnis (20) replies that ripening may not depend upon the living bacteria but upon their liberated enzymes. Whether such enzymes are able to diffuse from the centers where they are produced may be open to question; although from analogy with the ripening of soft cheese, where it is certain that the enzymes of surface moulds penetrate slowly toward the center, we must assume that they do.

The weighed evidence of microscopical examination supported as it is by Rodella's supplementary method, seems to indicate rather clearly that the bacteria are grouped in large clusters.

But the point in question is whether these colonies are correlated with the holes. Troili-Petersson (30) found lying in the walls of the holes of Swedish "Güterkäse" long slender colonies of bacteria spread out parallel with the walls. This vegetation, however, appears not to be of any one species of bacteria, and the form and size of the colonies may have been simply due to their having the space in which to spread. Beijerinck (3) who made sections of Edam cheese expresses the opinion that the accumulations of colonies of bacteria and crystals of tyrosin, etc., which he observed are due to local causes but he speaks of no relation between colonies of bacteria and the gas bubbles he observed. Maggiora's (22) description of sections of overripe cheese give no further information. Rodella was more concerned with the relation of bacteria to ripening than with localization, and furnishes little information upon the point we are interested in. But Gorini (13) mentions in particular that no constant relation between these accumulations and the small cracks and holes of Grana cheese was observed.

It therefore appears that direct microscopical examination has afforded very little evidence to support the view that eyes develop where colony growth is greatest. In fact it is perhaps not pedantic to say, that, even if these methods had enabled us to observe strikingly greater aggregations of bacteria about holes they would afford no conclusive evidence on the point at issue since they do not take into consideration the physiological powers of the organisms. This leaves the results of microscopical examination open to the same objections previously made against the cultural studies so far used.

Clark (6) has shown that not only regions about eyes but solid parts of cheese distant from eyes are active in the production of gas. In the experiment described the eye regions were, indeed, the more active; but in another experiment conducted since the publication of the first, no difference was observed. These observations, combined with the fact that the solid cheese mass itself contains very considerable quantities of CO_2, invalidate any such calculation as that made by Jensen (18) in one of his earlier papers in which he attempted to show that the gas produced by Freudenreich's *Bacillus E* was sufficient in that it furnished somewhat more than enough gas to fill the "eye" space of an ideal cheese.

Until the specific origin of the gas is more definitely known, and until these bacteria have been located in greatest abundance at points of eye formation, or their liberated enzymes have been shown to have their action confined to these localities, the evidence at hand is in favor of the view that the gas is produced more or less evenly throughout the whole body of the cheese.

One further argument is almost sufficient of itself. If eyes start about colonies, how is it that these colonies are so sparsely distributed? In a prime cheese of 1896 the eyes according to Bächler (1) were rather evenly spaced 2–4 centimeters apart. With the development of the modern large-eyed export cheeses, the spacing of the eyes has increased greatly. *Yet colonies of bacteria occur so thickly distributed that they may be seen in almost any microscopic section.*

THE FORMATION OF GASEOUS AGGREGATES

There is really little reason, as well as little evidence, to support the assumption that the gas *necessarily* separates as gas bubbles where it is produced. It is not at all irrational to suppose that the gas, having first saturated the cheese mass, separates at advantageous points which have no *necessary* relation to those localities rich in bacterial growth. In other words we may suppose a process similar to the growth of crystals to take place.

Everyone is familiar with the principal phenomena of crystallization, with the fact that to start crystallization from supersaturated solutions it is often necessary to "seed" them, and with the fact that the slower the rate of separation the larger are the crystals obtained.

A step nearer the point we are concerned with is found in the case of rain formation. Lord Kelvin (28) showed that the vapor pressure over a curved surface differs from that of a plane surface. If the curvature is convex the vapor pressure is greater than that of a plane surface. Neglecting the very important factor of electrically charged nuclei, raindrops must therefore form first upon some object such as a dust particle which presents a surface more nearly plane than that of a minute droplet. Were a minute droplet to be formed in an atmosphere just saturated with its vapor, the curvature of its surface, and consequently its vapor pressure, would be so large that it would immediately evaporate while condensation were still taking place on larger drops and dust particles. Thus we may say large drops are formed at the expense of small ones.

Attention should be called to the fact that the alteration in vapor pressure is exceedingly small until the drop becomes exceedingly small, with a diameter of perhaps a millionth of a centimeter; nevertheless the difference is sufficient to prevent the precipitation of innumerable minute droplets from the atmosphere and to determine the growth to a larger size of drops already formed.

With only slight modification Lord Kelvin's treatment of the vapor pressure at curved surfaces may be applied to the gas pressure at curved surfaces of a gas in solution.

Using Lord Kelvin's diagram, figure 1, let it represent a closed space containing an aqueous solution of carbon dioxide with plane surface at B, a capillary tube in which this solution rises to the point A where it retains a concave meniscus. Let the remainder of the space contain only gaseous CO_2 and water-vapor.

Let us assume that the density σ of the carbon dioxid remains uniform throughout the height h, and that it is acted upon by gravity with the constant acceleration g. Let the pressure of the carbon dioxid in its liquid phase be w at the plane surface B, while at the curved surface A it is w'. Then w' must be less

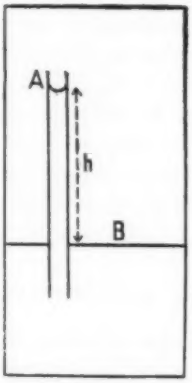

FIG. 1

than w by $g\sigma h$. Were it not so, CO_2 would distill from A and condense at B and work could be obtained contrary to the laws of thermodynamics.

Since vapor pressure and surface tension are related it may be profitable to look at this matter in another way. The pressure P tending to keep a bubble of gas spherical when suspended in a liquid is $P=\frac{2S}{a}$ (Willows and Hatschek) (32) in which S is the surface tension of the surrounding film and a the radius of the bubble. Since P balances the surface tension the pressure of the inclosed gas must overcome the surface tension if the bubble is to expand, but since P is inversely proportional to the radius

of the bubble, it is more difficult for very small bubbles to grow than for large bubbles.

If the separating gas already finds a film of gas, it will separate there rather than overcome the enormous force necessary to form *de novo* a tiny bubble.

This explains the observations frequently noted that any body having an adhering film of gas becomes covered with bubbles when placed in a solution saturated with gas.

There is then a striking analogy between the growth of crystals, the formation of rain drops and the growth of gas bubbles in a solution; an analogy whose physical manifestations are numerous and whose theoretical basis has long been accepted.

The quantitative estimation of the relationships established has been purposely avoided in the above treatment, because it would be difficult to apply them to such a heterogeneous substance as cheese or even to colloidal gels such as those of agar or gelatine. Nevertheless there is no reason to suppose that the principles do not apply to such gels; and by using these viscous media, which are capable of retaining gas bubbles as water solutions can not, we may obtain some striking verifications.

THE SEPARATION OF GAS AT POINTS DISTANT FROM THE SOURCE

If a sterile nutrient sugar solution of agar or gelatin be sown while molten with a pure culture of some gas-producing bacillus, such as B. coli, and then allowed to set, the gas liberated after a period of incubation separates as bubbles which are held in suspension. It can then be clearly seen that numerous colonies of bacteria have developed at some distance from the gas bubbles. The logical conclusion must be that the gas after having saturated the gel does not necessarily separate where formed, but tends to diffuse and separate into a bubble already started at some advantageous point. A more striking example is to be seen in the following experiment:

A hot sterile non-nutrient agar solution was poured into a sterile test tube, and when sufficiently viscous to retain a bubble of gas in suspension, such a bubble was introduced by blowing through a sterile

cotton-plugged glass capillary. To seal up any channel left by withdrawing the capillary a layer of hot sterile agar was poured upon the first. When this was thoroughly set an emulsion of nutrient agar and *B. coli* was poured on top. It was found that after a period of incubation, when the bacteria were presumably producing gas very vigorously, the pre-formed bubble in the non-nutrient agar increased very markedly in size. This experiment was repeated several times with uniform success. It may justly be taken to illustrate the hypothesis that the gas in a saturated colloidal gel will obey the principle deduced for pure aqueous solutions, namely, that large bubbles will be formed at the expense of small.

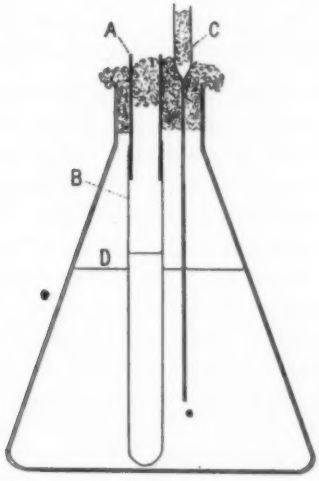

FIG. 2

In the above experiment it might be claimed with justice that into the original agar jelly there diffused sufficient food material for the bacteria to produce gas there; but it is improbable that within a few hours the bacteria in the supernatant culture could grow into, or by any probable means find their way into, the region where the initial bubble was blown. Indeed no growth about the bubble was observed.

In order to definitely preclude this source of error, the following arrangement was made (see fig. 2):

A collodion sac *B* was cemented with collodion to the glass tube *A*. It was then suspended in an Erlenmeyer flask. A nutrient sugar medium containing 1 per cent agar filled the Erlenmeyer within and without the sac to the level *D*, this level being considerably below the point where the sac was cemented to the glass tube. A very fine capillary tube *C*. with its upper end tightly plugged with cotton was then placed as illustrated, and the neck of the flask tightly plugged with cotton. The whole apparatus was then sterilized in an autoclave.

While the agar was still molten and at a temperature of about 40 degrees, that in the sac was inoculated with *B. coli;* and, when the agar on the outside of the sac was sufficiently viscous to hold gas bubbles in suspension, a few were blown in it by means of the capillary tube *C*. This capillary was then withdrawn. When all the agar had set, this flask was left at room temperature (about 22°) to incubate the bacteria.

As in the former experiment the pre-formed bubbles grew in size. The collodion sac was found to be intact at the close of the experiment. It had purposely been made rather thick to prevent the bacteria making their way through it. The above experiment was made in duplicate with like result.

Although Todd (29) found that collodion membranes were not impervious to B. *coli*, *Fuller* (11) the next year (1910) obtained results entirely at variance with those reported by Todd. Using Frost's (10) method he found it possible to make sacs which retained their bacterial integrity for several months. The same conclusion seems to have been reached by Heymans (17) (1912).

Although the experiments of Todd and Fuller contradict each other, it should be remembered that both investigators used fluid media while in the above experiment the medium contained 1 per cent agar. The collodion thus served simply as an additional barrier. Frost using *B. typhosus* and *B. pyocyaneus*, two organisms which Todd claimed penetrated collodion sacs, found that when the sac was embedded in gelatin, the organisms were retained perfectly.

There is then, every reason to believe that the bubbles which grew outside the sac and which were indeed more than 2 cm. from the sac were thoroughly separated from any bacterial contamination.

But if the proposed explanation be true, there follows an almost necessary corollary. To induce growth of a crystal time must be allowed for delicate adjustment of equilibrium else new crystals will be formed soon to compete for the substance in solution upon an equal basis with the first formed crystals. In like manner the rate of gas production must be low if a bubble already formed is to grow without competition, for if the gas is formed rapidly it can not become diffused and distributed from the points of production rapidly enough to prevent supersaturation of these regions. When this supersaturation becomes sufficiently great the gas must separate from solution. Consequently when the rate of gas production in a culture is rapid many small bubbles will be formed; and when the rate is slow the tendency will be toward the formation of larger aggregations or larger bubbles.

An illustration of this is furnished by Mr. Ayers of this laboratory. In some studies on the Wisconsin curd test Mr. Ayers found that curds containing numerous gas producing bacteria, and consequently subjected in general to a high rate of gas production, were filled with numerous very small holes, while curds containing fewer bacteria, and consequently subjected to a lower rate of gas production, were inflated with larger holes. It may of course be said that the number of holes correspond to the number of colonies; not a numerical correspondence, for such does not occur, but a parallelism. On this basis we might perhaps explain Mr. Ayers' observations by saying, that when a certain number of colonies in a thickly seeded culture have formed a small bubble, other groups of colonies throughout the medium have done likewise and at the same time have formed sufficient acid to prevent further growth of bacteria and consequently further gas formation. The result would then be numerous small bubbles. On the other hand if the colonies are very much less numerous the surrounding regions would furnish by diffusion both more food per colony and more absorption of acid per colony. In consequence, large holes would be produced. This explanation while plausible is only partially justified. In the first place there is no numerical correspondence

between the number of colonies and the number of holes as can be seen with the naked eye in a clear gelatine culture of *B. coli*. It must therefore be granted that the gas, before it separates, actually does diffuse from the points where it is formed. Postulation of extra-cellular gas-producing enzymes would only emphasize this, since such enzymes if at all diffusible would be even more widely distributed than the bacteria. But in the second place, the writer has found that of two 200 cc. flasks of the same gelatine media each inoculated with 760,000,000 bacteria, that kept at 15° had larger gas holes than that kept at 20°. It is difficult to explain this except on the basis that the 15° culture had a lower rate of gas production which allowed time for larger bubbles to grow just as in the crystallization of salts the larger crystals will be formed during the slower crystallization.

Although factors other than the rate of gas production may influence the size and number of gas holes in a culture, the chief factor seems to be the rate.

APPLICATION OF THE PRINCIPLE TO CHEESE

It therefore follows that a rapid production of gas in cheese would result in the formation of numerous small holes, while with a slow rate the holes would tend to be large. In general it may be said at once that such a relationship does occur. The Nissler holes of Swiss cheese are small, and they are formed rapidly. The eyes are only formed after some time has elapsed, and grow with extreme slowness.

At this point it may be well to comment upon some objections which have doubtless occurred to the reader. In the first place are there not in cheese a sufficient number of gas bubbles enclosed in the curd during the manufacture to furnish innumerable gaseous nuclei for the separation of innumerable bubbles instead of relatively few "eyes." Examination of curd grains in the kettle do indeed sometimes show that they have adhering to them bits of froth, but it must be remembered that when the cheese goes to press its temperature is high and that these tiny bubbles may be absorbed when the cheese cools. If one blows *tiny*

bubbles in a viscous solution of agar (40°) or in a fairly warm gelatine solution, these bubbles will be seen to entirely disappear as the solution cools—provided of course the bubbles were originally not too large. There can be little doubt that a like absorption takes place in cheese.

It may further be questioned whether the solid particles of cheese do not furnish innumerable nuclei for the separation of gas bubbles just as dust in the atmosphere furnishes the nuclei for the condensation of rain. To this question we have a positive answer in the experiments of Gernez (12).

Gernez found that in the separation of gas from supersaturated solutions solids alone do not serve as nuclei. A film of gas upon the solid surface is an absolute essential. If a glass rod is plunged into a supersaturated gas solution bubbles are formed upon those surfaces which had been exposed to the air; but if the rod is broken while in the solution no bubbles form upon the freshly exposed surface. Likewise, precipitates if formed in gas-free solutions, do not serve as nuclei for bubbles when placed in supersaturated gas solutions. It appears then that a solid, if it is to serve as a nucleus for a gas bubble, must have a surface film of gas.

We are therefore justified in believing that the cheese curd goes to press with few so-called nuclei of any kind which may induce the growth of gas holes.

But let us see what further evidence there is that the formation of gas holes in cheese does follow the analogy to crystal growth which has been proposed.

Freudenreich (8) in his cheese making with *B Schafferi* found that this organism could produce Nissler cheeses and also blown cheeses; and he therefore considered that these faults are not necessarily due to different bacteria.

Freudenreich's explanation was as follows: If the bacteria are allowed to develop to such an extent before the cheese is made that they are numerously and evenly distributed throughout the milk, Nissler holes are formed because there are numerous colonies. If, however, the cheese is made up directly after inoculation the colonies are fewer and the cheese develops

blow holes. Undoubtedly there is a good deal in this theory; but it should be asked if even in Nissler cheeses we are to assume the number of colonies equal only to the number of gas holes, and especially so when these holes are several centimeters apart. If we look over carefully Freudenreich's paper we shall find in the first place that his Nissler cheeses were those which gased in press while his blown cheeses took a week or ten days to blow; indicating that the time factor was an important one, and that what we may call the crystallization of the gas was the important factor. Furthermore it is significant that in at least one of Freudenreich's crucial experiments the bacteria introduced were not allowed to develop before but *after* the addition of the rennet. Now it is known that rennet acting upon pasteurized milk such as Freudenreich used in this experiment takes longer to produce a firm enough curd for cheese making; nevertheless it rapidly, sometimes more rapidly than in raw milk, produces a thin coagulum. Therefore in Freudenreich's experiment we would surely not expect the bacteria to have been scattered after the addition of the rennet but to have attained larger colony growths. If this assumption be correct we would have expected a blown cheese according to Freudenreich's hypothesis. Instead he obtained a Nissler. The simpler explanation appears to be that he obtained in this case colony growth of such extent that a rapid gas production took place, and that, in consequence of this high rate, the gas had to separate close to the points where it was produced.

Of course this interpretation must not be construed too rigidly. If there are present in the milk particles of cow dung, the infection of the cheese may become so rank at certain points that nothing short of a blow hole will be produced at these points. Jensen (18) actually observed this correlation and Freudenreich (8) found that paper pellets soaked in a culture of *B. Schafferi* produced blow holes in the cheese about these rank infections.

In such a case the gas, though it may separate at frequent points near its origin and though it may tend to produce a "Nissler" cheese can not stop short of the production of a "blown" cheese with large holes because of the abundance of the gas which

must separate. The holes of such *rapidly* blown cheeses however reveal the manner of their formation by the irregularity of their contour. They appear to have been distended by a more or less explosive gas production and are without that clean-cut, neatly spherical contour of the perfect eye, which results when time is allowed for the adjustment of tensions.

STAINED CHEESES

One test to which we may subject the hypothesis which has been suggested is the following: If Nissler holes are formed at the points where the gas is produced or even close to those points, then no particular locality in the cheese should be favored provided the bacteria are distributed both within and without the curd grains. On the other hand, if normal eyes are formed so slowly that time is given for the gas to assemble and separate at favorable localities, we should expect to find these localities to be of some definite nature.

That the bacteria in fresh curd are distributed both within and without the curd grains can not be doubted, although it may be that their numerical distribution differs. Harrison and Connell (15) state that upon inoculating milk, with a gas-producing organism more of these were found on the exterior of the curd particles than within. Russell and Weinzirl (26) found fewer organisms in the curd than in the expressed whey.

On the other hand Hastings, Evans and Hart (16) find that the curd retains the greater part of the bacteria found in milk. These observations apply to Cheddar curd. Freudenreich and Jensen (9) observed that in the manufacture of Swiss cheese the greater part of the bacteria were to be found within the curd grains.

If it be permissible to draw a definite conclusion from this, it is that the method of manufacture of Swiss cheese, and especially the high cooking temperature, is least destructive to the bacteria within the curd. We should therefore expect the gas producers in a Nissler cheese to be distributed both within and without but predominatingly within the curd grains.

In 1896, Bächler (1), an experienced cheese maker, proposed that eyes are formed between curd particles. The writer has been unable to obtain a copy of Bächler's original paper but from abstracts has gathered that his view was as follows:

When the curd is hooped, if the whey is not thoroughly expelled from between the curd particles, pockets of whey will be retained. After the cheese leaves the press the whey from these pockets will be absorbed and a "weak" spot left. Whether Bächler meant an actual hole or a place where the curd grains were imperfectly matted is not clear. The latter interpretation is probably more just, for Bächler must have observed the irregular holes, so-called "mechanical holes," which sometimes occur in weakly pressed curd, and he would not have mistaken these for incipient eyes. A normal eye from the moment of its origin retains its characteristic spherical shape, and, when small, closely resembles a Nissler hole. It is probably imperfectly matted curd grains which Bächler meant by weak spots.

If this be so, it is obvious that a method of testing his hypothesis would be to so stain the surface of each individual curd particle that in the solid cheese its outline would remain distinct. If in a cheese so stained a gas hole should form *between* curd particles its interior wall would be *colored*; while if it should originate *within* a curd grain the interior wall would remain *uncolored*. An admirable dye for this purpose was found in Congo red. When this was sprinkled into the kettle just before the curd was drawn it stained the surface of each curd grain a uniform red and did not penetrate. A cross section of a cheese so stained revealed the distinct outline of each original curd particle.

Two stained Nissler cheeses were made by the addition of cow dung to the milk. Upon cutting these cheeses when taken from the press it was found that the gas bubbles were not correlated with any particular locality. In numerous instances they were clearly seen to be wholly within the curd particles, while in other cases they had pushed aside the walls and formed holes whose interior walls were stained.

On the other hand, stained and apparently normal cheeses which developed apparently normal eyes presented a very differ-

ent appearance when cut. Almost without exception the holes had the characteristic appearance of normal eyes, and *their interior walls were all without exception stained.*

There can be little doubt therefore that no particular locality is favored when Nissler holes form while, at least in the experimental cheeses, the eyes without exception developed between curd grains. This is in harmony with the hypothesis that the gas of Nissler holes, because it is formed rapidly, must escape from solution near where it is formed, while the gas of eyes, having time to diffuse and to keep a closer equilibrium between its gaseous and liquid phases, separates first at a favorable locality, and there forms an aggregate comparable with a crystal.

We must be careful to say that "at least in the experimental cheeses the eyes developed between curd grains." The dye used injured to a slight extent the matting quality of the curd, so that there may have been produced artificially those weak spots suggested by Bächler. If so, it alters in no way the validity of the argument that eye development takes place in favored localities, although some slight doubt may be thrown upon the conclusion that in an undyed cheese these places are between curd grains.

Closer examination of the eyes of dyed cheese reveals an interesting point. It was noticed that in a great majority of cases the interior walls of the eyes were not uniformly stained. A small portion was unstained and almost of as clear a white as an undyed curd grain. Inspection of the curd grains in the vat showed that they were generally uniformly stained but occasionally enfolded surfaces and occasional unopened cracks were detected whose surfaces the dye had not reached. An eye developing in contact with such a surface would have its interior wall only partially colored.

In regard to the nature of the localities at which the gas separates there is, beside the hypothesis of Bächler (1) that of Schaffer (27). Schaffer's studies of eye development as followed with the X rays led him to believe that the regions of eye growth were regions of sufficiently active proteolysis to allow the curd to be absorbed and give way to the expansion of the

gas. Schaffer tried to explain away Jensen's finding that there was no distinct difference in the composition of the cheese near eyes and distant from them; but, while we admit that Jensen's method of analysis was not very delicate, we must also admit that Schaffer's evidence is of somewhat dubious value.

Why any particular locality should be favorable to the development of a gas bubble it is difficult to say; but from the striking appearance of the eyes of cheeses stained with Congo red, it is very evident that the eyes *do* start at particular points. Whether or not the eyes originated between curd grains, the surfaces of the eyes ultimately involved the surfaces of the curd grains.

Perhaps the unequal coloring of the eye surfaces is due as suggested to an unstained surface being involved; perhaps it is due to some proteolytic effect such as Schaffer has suggested whereby the interior of the curd grains became exposed; perhaps the Congo red was reduced.

Whatever the situation may be, the fact remains that the stained cheeses clearly demonstrate a difference in the locality of Nissler holes and normal eyes, a difference which demonstrates the only point with which we are now concerned; namely, that a sudden evolution of gas will result in many small gas bubbles located where the gas is produced, that with a slow evolution of gas, separation takes place at favorable places only.

The position of any particular eye, its rate of growth and its ultimate size depend upon a great many factors. We have not considered the influence of the texture of the cheese, its permeability to gas, the tension of the rind, nor the influence of proteolysis, and of the fat content upon the surface tension of an eye surface. These all must be considered in time, and to prevent confusion each should receive attention separately. All of these factors however are merely modifying influences, and none affects the validity of the argument that the gas in separating into bubbles in cheese follows the same laws that it does in beer and the same laws that apply in different degree only in the separation of gaseous liquid or solid aggregates from their saturated solutions.

SUMMARY

A review of the literature reveals little or no evidence that the eyes of Emmental cheese are strictly localized at points of excessive bacterial growth. On the contrary the evidence of bacterial counts, and direct microscopical examination as well as the gas production of different regions of the cheese indicate a more or less uniform distribution of the eye distending gas.

Certain theoretical considerations are presented which lead to the hypothesis that the gas separates in aggregates according to laws governing the separation of gas from supersaturated aqueous solutions. This hypothesis has been tested upon viscous media with results directly applicable to the "eye" and "Nissler" hole formation in cheese.

It is concluded that the gas produced in Emmental cheese separates in aggregates whose localities have no necessary relation to the points where the gas is produced, that a rapid gas production must tend to the formation of numerous small holes while a slow gas production must admit the formation of larger holes. This conclusion is shown to agree with the fact that Nissler holes are produced by a rapid fermentation while eyes are formed slowly. This conclusion also suggests that the gas of Nissler holes must separate at numerous points near its point of origin without regard to any particular locality of the cheese; while the eyes must form at favorable points.

This was experimentally verified by a study of stained cheeses.

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THE INFLUENCE OF SALT ON THE CHANGES TAKING PLACE IN STORAGE BUTTER

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INTRODUCTION

It is generally believed, and most experimental evidence supports this belief, that salt improves the keeping quality of butter. McKay and Larsen (1) give as one of the reasons for salting butter "to increase the keeping quality. . . . . That salt is antiseptic is no longer a doubt. . . . . so far as the keeping properties of butter are concerned it would be advisable to salt butter as highly as 6 per cent." In their own experimental work (2) salted butter kept much better than unsalted butter when held at 50°F. The sweet butter became cheesy and mouldy. Rahn, Brown, and Smith (3) secured similar results at 21°F. and also observed that the increase in acidity was greater for the unsalted butter. In salted butter held at 50° to 60°F., Larsen, Lund and Miller (4) found that lightly salted butter developed the greater degree of acidity and they associated the increase in acidity with the decrease in score. The most highly salted butter had the better keeping quality. On the other hand, Gray (5) proved that "butter containing low percentages of salt kept better than did butter of the same lot containing higher percentages of salt," when stored at −10°, 10°, and 32°F.

From the literature on the subject, it is apparent that the influence of salt on the keeping quality of the butter varies according to the temperature at which it is held. When held at temperatures which do not stop bacterial growth, the highly salted butter seems to keep best, the low salted butter next, and the unsalted butter has the poorest keeping quality. When held at temperatures which inhibit bacterial growth, the lightly salted butter keeps better than either highly salted or unsalted. No good reason could be found in the literature for the apparent inconsistency.

SCOPE OF THE INVESTIGATION

It has been the personal observation of many men that unsalted butter in commercial cold storage keeps as well as or better than salted butter. The experiment reported in this paper deals with this point and considers only salted versus unsalted butter. The butter was first held for the usual cold storage period in a commercial cold storage butter room and was then held for a short time at the usual ice box temperature. This latter treatment is comparable to that which commercially stored butter would receive before being consumed. At each scoring the usual bacteriological and chemical analyses were made so that probable causes of a possible difference would not be overlooked.

MAKING, STORING, AND SCORING THE BUTTER

The cream was sweet clean cream of good flavor. It was ripened without pasteurization or the addition of a starter to an average acidity of 0.58 per cent lactic acid. It churned in twenty to thirty minutes; the churning was stopped at the wheat kernel stage; the butter was washed twice; salted or not; and worked from twenty-three to twenty-seven revolutions in a Victor double roller churn. Half the butter of each churning was salted and worked, and the other half worked unsalted so that each sample of unsalted butter had an exact duplicate in the salted butter. It was then packed into 5 pound paraffined wooden butter drums lined with parchment paper. Enough of these containers were packed so that one from each lot could be taken out at every scoring. Initial data as to score, chemical and bacteriological analysis were obtained.

The butter was stored in the butter storage room of Booth Fisheries Company, St. Paul, at a temperature of −15°F. After 284 days (9½ months) in cold storage, it was then held for twenty days in a butter-cutting room at 58° to 60°F.

It was all scored by James Sorensen, Manager of the Albert Lea State Creamery and S. G. Gustafson, State Creamery Inspector. Some of the butter was also scored by A. O. Storvick of the Federal Dairy Division, and Chris Johnson, State Creamery Inspector.

INFLUENCE OF SALT ON SCORE

The scores given are based entirely upon the flavor. They are arranged according to churnings so that below each score of the unsalted butter is its counterpart containing salt. The deterioration is figured for a total of 284 days at −15°F; and a grand total for the entire 304 days.

TABLE 1

Influence of salt on score

CHURNING	SALT	−15° F.				58° F.		TOTAL DECREASE
		Initial score	113 day score	284 day score	284 day decrease	304 day score	304 day decrease	
1	0	91.75	89.00	91.00	0.75	90.00	1.00	1.75
	2.51	90.75	88.00	89.25	1.50	86.00	3.25	4.75
2	0	91.00	89.75	90.00	1.00	90.00		1.00
	2.07	91.25	89.25	89.25	2.00	87.00	2.25	4.25
3	0	93.00	91.25	91.00	2.00	91.75	+0.75	1.25
	1.72	93.25	90.00	90.50	2.75	88.00	2.50	5.25
4	0	92.50	91.25	89.50	3.00	90.75	+1.25	1.75
	3.27	92.50	90.62	88.75	3.75	88.25	0.50	4.25
5	0	95.00	92.00	92.75	2.25	92.00	0.75	3.00
	3.79	92.75	92.25	90.25	2.50	87.50	2.75	5.25
6	0	94.25	89.75	89.50	4.75	90.00	+0.50	4.25
	2.41	94.00	90.50	89.25	4.75	87.25	2.00	6.75
Average	0	92.94	90.50	90.62	2.29	90.75	+0.13	2.17
	2.63	92.42	90.10	89.54	2.87	87.33	2.21	5.03
Difference in favor of unsalted		0.52	0.40	1.08	0.58	3.22	2.33	2.91

At the end of 284 days at −15°F., the unsalted butter had lost 2.29 points in score while the salted had lost 2.87 points; a difference of 0.58 in favor of the unsalted butter. A difference in favor of the unsalted butter held true in five out of the six churnings and tied in the sixth, but since the average is of only six lots, such a small difference, 0.58, might be ignored, if it were

not followed by similar evidence in greater degree when held at the warmer temperature. While the results are contradictory to those of Rahn, Brown, and Smith (3), they are not comparable because these investigators failed to work the unsalted butter in its manufacture and the temperatures employed did not freeze it in storage.

During the twenty day holding at 58°F., the unsalted butter did not deteriorate noticeably in flavor for it averaged 0.12 points higher in score than at the start. The salted butter lost 2.21 points in score, a difference of 2.33 points in favor of the unsalted butter. The total decrease in the score of the unsalted butter was 2.17 and for the salted 5.08, a difference of 2.91 in favor of the unsalted butter. Every sample of unsalted butter scored 90 or above while every sample of salted butter scored below 90.

The comments of the judges on the butter are given in the following table.

The most common criticisms were metallic, oily, and fishy. These three flavors appear to be associated with each other. At the 113 day scoring, seven out of twelve packages were criticized as metallic and two as fishy; at the 284 day scoring two were metallic and eight were fishy; at the 304 day scoring none were metallic and ten were fishy. The metallic flavor had changed into oily and thence into the fishy flavor. Out of a total of 24 drums of each kind of butter scored, seven, or 29 per cent, of the unsalted were criticized as being fishy against fifteen, or 62 per cent, of the salted. The intensity of this flavor was usually more pronounced in the salted butter. After the twenty days holding at 58°F., the body of all six samples of unsalted butter was criticized as being weak and overworked, while only one of the salted samples showed this fault. No satisfactory explanation can be offered for this fact. The only difference in the composition caused by moisture loss during storage, was the 3.15 per cent (or 26 per cent) greater moisture content of the unsalted, which through freezing and warm holding may have caused the conditions noted.

TABLE 2

Judges comments on the butter

CHURNING	− 15° F.			58° F.
	Initial	113 day	284 day	304 day
		Salted		
1	Tendency to fishy	Fishy	Fishy, slightly unclean	Fishy, bad
2	Tendency to fishy	Metallic	Slightly oily, slightly fishy	Fishy
3	Will not go fishy	Metallic	Slightly oily, slightly fishy	Fishy
4	Good	Metallic	Fishy	Fishy
5		Coarse, not fishy	Coarse, unclean	Fishy
6		Fishy	Fishy, coarse	Fishy, overworked, body poor
		Unsalted		
1	Dry	Rancid, metallic	Metallic, cheesey slightly unclean	Fishy, overworked, body poor
2	Good	Trifle rancid	Slightly fishy, slightly unclean	Fishy, overworked, body poor
3	Good	Trifle moldy, cheesey	Slightly unclean, metallic	Weak body, bitter, curdy
4	Good	Metallic, old flavor	Fishy	Weak body, overworked, slightly fishy
5	Extra fine aroma	Slightly metallic	Good aroma, slightly oily	Flat, storage flavor, weak body
6		Metallic	Slightly oily slightly fishy	Weak, body fishy

INFLUENCE OF SALT ON BACTERIAL ACTIVITY

Bacterial counts were made of the butter and the organisms classified according to their action on milk. The latter proved to be of little value.

The extreme variation in the initial counts make them of no comparative value. Between the initial and 113 day counts the bacteria had died out rapidly. At the end of 113 days every

sample of unsalted butter contained more bacteria than its salted duplicate and similar though less uniform results were obtained at the end of 284 days. The averages agree with the findings of Rahn, Brown, and Smith (3), that the initial count of the unsalted butter was the higher and that "the decrease in the cold storage samples is larger in the unsalted samples." The low

TABLE 3

Bacteria in thousands per cubic centimeter

CHURNING	SALT	−15° F.					58° F.	
		Initial	113 day	284 day	Decrease	304 day	20 day changes	
							Increase	Decrease
1	0		320	448		5,280	4,832	
	2.51		672			4		
2	0	944	28	164	780	2,000	1,836	
	2.07	3,984	376	108	3,876	48		60
3	0	3,756	100	280	3,476	2,880	2,600	
	1.72	3,248	360	560	2,688	96		464
4	0	5,466	44	52	5,414	1,360	1,308	
	3.27	700	52	224	476	17		207
5	0	9,862	240	432	9,430	2,560	2,128	
	3.79	2,250	456	2,320	+70	144		2,176
6	0	10,560	26	176	10,384	1,600	1,424	
	2.41	3,464	54	272	3,192	10		260
Average	0	6,117	126	220	5,896	2,613	2,393	
	2.63	2,729	328	606	2,032	53		643

temperature was so important in preventing bacterial development that the antiseptic property of the salt played a minor rôle. The *Bacterium Lactis Acidi* withstood the adverse conditions better than all other organisms. Yeasts or molds did not increase at this cold temperature.

During the twenty days holding at 58°F. to 60°F., marked changes occurred in the bacterial content. Temperature and moisture conditions were favorable to bacterial growth and to

general decomposition. In the unsalted samples, *Bacterium Lactis Acidi*, *Oidium Lactis*, and two species of yeasts grew and increased the germ counts 2,393,000 per cubic centimeter or 1088 per cent, while in the salted samples the salt inhibited all bacterial growth and there was an actual decrease of 643,000 per cubic centimeter or 92 per cent in germ content.

The only organism which appeared regularly in every sample of butter was *Bacterium Lactis Acidi*. The average percent of the total number which was this organism is shown by the following table.

TABLE 4

Percentage increase Bacterium Lactis Acidi during storage

SALT	INITIAL	113 DAY	284 DAY	304 DAY
per cent				
0	82.19	98.98	99.69	99.60
2.63	96.50	99.83	99.59	100.00

Since the percentage of *Bacterium Lactis Acidi* increased during storage, they died out less rapidly than the other organisms. At the end of the experiment every sample of salted butter was a pure culture of *Bacterium Lactis Acidi*, while the unsalted butter also contained an average of 3000 yeasts and 5300 *Oidium Lacti* per cubic centimeter.

INFLUENCE OF SALT ON ACIDITY

In the following table the acidity of the butter is expressed as the number of cubic centimeters of a tenth-normal NaOH solution required to neutralize ten grams of butter using phenolphtalein as indicator.

From the above table it is seen that the initial acidity of the unsalted butter is uniformly higher, average 0.12 cc., than the salted. This is due to the fact that the salted butter contained a little less water and that the water itself is slightly acid to phenolphthalein. At the end of the 284 days at low temperature, the increase in acidity of sweet and salted butter is equal, but after holding at the warm temperature, the unsalted butter had

TABLE 5

Influence of salt on acidity

CHURNING	SALT	−15° F.				58° F.		TOTAL INCREASE
		Initial	113 day	284 day	284 day increase	304 day	20 day increase	
	per cent							
1	0	1.36	2.05	2.15	0.77	2.72	0.59	1.36
	2.51		1.72			2.08		
2	0	1.50	1.50	2.04	0.54	2.56	0.52	1.06
	2.07	1.32	1.75	1.88	0.56	2.07	0.19	0.75
3	0	1.38	1.91	2.05	0.67	2.89	0.84	1.51
	1.72	1.29	1.77	1.83	0.54	1.85	0.02	0.56
4	0	1.38	1.72	1.83	0.45	2.47	0.64	1.59
	3.37	1.29	1.77	1.83	0.54	2.02	0.19	0.73
5	0	1.57	2.21	2.23	0.66	2.87	0.64	1.30
	3.79	1.39	1.98	1.94	0.55	2.25	0.31	0.86
6	0	1.50	1.66	1.93	0.43	2.78	0.85	1.28
	2.41	1.35	1.79	1.88	0.53	2.09	0.21	0.74
Average	0	1.45	1.84	2.03	0.58	2.71	0.68	1.26
	2.63	1.33	1.51	1.87	0.54	2.06	0.18	0.73
Amount of greater increase in unsalted		0.11	0.33	0.16	0.04	0.65	0.50	0.54

increased 0.53 more than the salted. This difference may be accounted for in two ways: (1) the action of milk lipase, an enzyme which causes an increase in the acidity of stored butter, according to Rogers (6), would be inhibited by strong salt solutions; (2) microbial growth in the unsalted butter which consisted of *Bacterium Lactis Acidi*, acid producing yeasts, and *Oidium Lactis*. The *Bacterium Lactis Acidi* might increase the acidity slightly by the lactic formed from the sugar; the yeasts by the liberation of free fatty acids (6); and *Oidium Lactis* by an action similar to that of the yeasts (7).

INFLUENCE OF SALT ON MOISTURE

In order that some of the results of the moisture determinations can be explained a table showing the relation of moisture to salt is also given.

TABLE 6

Influence of salt on moisture content

CHURNING	SALT	INITIAL MOISTURE	284 DAY MOISTURE	DECREASE
	per cent	*per cent*	*per cent*	
1	0	15.92	15.23	0.69
	2.57			
2	0	15.06	14.58	0.48
	2.07	14.58	12.48	2.70
3	0	15.84	15.98	+0.14
	1.72	15.45	12.64	2.81
4	0	14.73	14.65	0.08
	2.27	14.40	11.47	2.91
5	0	15.05	15.05	0.00
	3.79	14.59	11.00	3.59
6	0	14.83	14.78	0.05
	2.41	14.01	11.92	2.09
Average	0	15.24	15.05	0.19
	2.65	14.61	11.90	2.70
Per cent more moisture in unsalted butter		0.63	3.15	2.51

The initial moisture content of the unsalted butter averaged 0.63 per cent higher than that of the salted, the difference being quite uniform for the duplicates. During the total cold storage period, the unsalted butter lost only 0.19 per cent in moisture, while the salted butter lost 2.70 per cent, or the salted lost 2.51 per cent more moisture than the unsalted. Since the unsalted butter was a frozen solid very little loss in moisture would be expected. In as much as the salted butter lost heavily both in moisture and salt, there must have been a leakage from the inside to the outside. In other words, it could not have been frozen.

It is a principle in physics that upon cooling any salt solution, the water will freeze out or the salt crystallize out, depending upon the strength of the solution, until the salt concentration is 22.5 per cent and the temperature is −6.5°F. It then freezes into a solid mass. The butter was cooled below this freezing point.

This abnormal cooling of butter below the freezing point of its water solution without freezing it was also observed by Rahn, Brown, and Smith (3) who stored unsalted butter at 21°F. and found it unfrozen. They explained it by the phenomenon

TABLE 7

Relation of salt to moisture in the salted butter

CHURNING	INITIAL SALT	284 DAY SALT	DECREASE IN SALT	INITIAL BRINE CONCENTRATION	284 DAY BRINE CONCENTRATION	LOSS IN BRINE CONCENTRATION	CONCENTRATION OF LOST BRINE
	per cent	*per cent*					
2	2.07	1.07	1.00	14.18	8.57	5.61	47.62
3	1.72	0.91	0.81	11.13	7.19	3.94	28.82
4	3.27	2.14	1.13	22.71	18.65	4.06	38.57
5	3.79	2.10	1.69	25.97	19.18	6.79	47.11
6	2.41	1.62	0.79	17.20	13.59	3.61	37.79
Average...	2.65	1.57	1.08	18.24	13.19	5.05	40.00

that "water, if kept quietly in clean, smooth walled containers, may be cooled to several degrees below the freezing point without becoming solid." A consideration of the relation of salt to water in the butter reveals a more probable explanation in this particular case. The butter lost 1.08 per cent in salt and 2.70 per cent in moisture and the concentration of this brine is 40 per cent. The concentration of salt in the water remaining in the butter decreased 5.05 per cent. During the slow, undisturbed cooling to −15°F., the water had frozen out as ice and the salt remained in solution making a supersaturated brine. The freezing point of this brine was lower than the temperature at which it was held.

PROTEIN CONTENT

Analyses for protein gave almost as great a variation in the samples of different tubs from the same churning as there was between different churnings. Such an uneven distribution of the protein must have been caused by (1) high acid in the cream causing minute clots of casein to be formed; (2) churning in a short time which failed to break up these clots. The protein (nitrogen $\times$ 6.38) content of the butter was unusually low ranging from 0.47 to 0.68 per cent, average 0.55 per cent. Churning to the wheat kernel stage and washing twice were the probable causes of this low protein content.

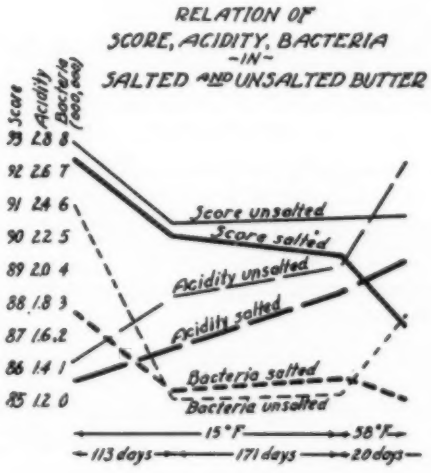
RELATION OF SCORE, ACIDITY, AND BACTERIA IN SALTED AND UNSALTED BUTTER

Score, acidity, and bacteria are popularly associated with each other. Conditions which favor a decrease in score favor an increase in acidity and bacteria. From the graph, it is evident that during the storage at -15°F. the changes taking place in the salted and unsalted butter were very similar. There was a decrease in score; a decrease in bacteria during the first half and the number remained constant during the last half of the storage period; and a gradual increase in acidity.

During the period of holding at 58°F. the changes occurring were very rapid and different. The unsalted butter remained constant in score, but the acidity and bacteria increased very markedly. The salted butter deteriorated rapidly in score; the bacteria decreased in number; and the rate of increase in acidity was only slightly accelerated. According to the generally accepted relation of bacteria and acidity to score, the score of the salted butter should have decreased less than that of the unsalted, but the results obtained were the exact opposite of this. There was no relationship in these three changes.

The bacteria which grew in the unsalted butter were not the kind that produce bad flavors, shown by the fact that the score of the butter did not decrease. In other words, the better

keeping quality of salted butter over unsalted butter held at warm temperatures due to the antiseptic property of the salt was entirely elminated in this butter because the organisms which developed in the unsalted butter produced no off-flavors. Salt itself, exclusive of its beneficial antiseptic property, causes an increase in the rate of deterioration in butter which amounted to 2.33 per cent in score in this particular case. At −15°F., deterioration was so slow that this difference was not marked.



Under ordinary conditions the increase in keeping quality due to the antiseptic property of the salt more than offsets the deterioration caused by the salt itself. When bacterial growth is checked by very cold temperatures it has been proven that the lightly salted butter keeps better than the heavily salted which falls into line with the results of this experiment.

SUMMARY

1. Salt, exclusive of its antiseptic property, hastened the deterioration of the butter.

2. When stored at −15°F., unsalted butter kept as well as salted butter.

3. The bacteria in the unsalted butter decreased more rapidly at −15°F., than they did in the salted butter and increased more rapidly at 58°F.

4. The acidity of the unsalted and the salted butter increased uniformly at −15°F. but at 58°F. the increase was greater in the unsalted butter.

5. Moisture was lost from the salted butter but not from the unsalted at −15°F.

6. Little if any relationship existed between the bacteria, the acidity, and the score in this butter.

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BLOWING RENOVATED BUTTER OIL AT PASTEURIZING TEMPERATURE[1]

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INTRODUCTION

Among renovated-butter makers there is a rather widely prevailing opinion that the butter oil used as the basis for renovated butter can not be subjected to the pasteurizing temperature during the process of blowing without injuring the flavor, grain, and keeping quality of the finished product.

In the following investigation, which was designed to ascertain whether there is ground for this opinion, renovated butter was made under factory conditions from both pasteurized and unpasteurized butter oil. The unpastuerized butter oil was blown at the temperatures usually employed in the industry, while the other oil was blown at the pasteurizing temperature. All other conditions of manufacture were the same in both cases. The renovated butter was scored while fresh and after having been held in cold storage.

PRELIMINARY INVESTIGATIONS

Experiments were first conducted with a small laboratory apparatus, having a capacity of about 10 pounds, and modeled after the combined blower and emulsifier in use in some of the smaller factories. Later several runs were made with a larger equipment with a capacity of about 100 pounds. In this equipment the blowing tank was separate from the emulsifier, the latter being of the double dasher type. Briefly, the runs, were made as follows: The packing stock was melted and settled at a temperature below 110°F. The clear butter oil was divided

[1] Published by permission of the Secretary of Agriculture.

into two parts. One part was blown at the pasteurizing temperature, about 140°F., and the other part serving as a check was blown at a temperature of between 110° and 120°F. In some cases the pasteurizing temperature was raised to 160°F. The subsequent operations of emulsifying with ripened skimmed milk, crystallizing, and working with a hand worker, were as nearly identical as it was possible to conduct them. The finished product was given to different consumers, each receiving a pasteurized and an unpasteurized sample marked in such a way as to be meaningless to them. They were requested to use the two samples as ordinary butter and to comment on them and state their preference.

Inasmuch as this work was preliminary, the detailed reports of the consumers will be omitted. In the majority of cases no differences could be detected by the consumer. In other cases some reported that the pasteurized sample possessed better quality, while others reporting on the same lot stated that the unpasteurized sample was the better. It was very evident that, if there was a difference in flavor between the pasteurized and unpasteurized samples, the difference was too small to be detected by the ordinary consumer.

INVESTIGATION AT FACTORY

Through the courtesy of the owners of one of the largest and best-equipped factories in the country, its facilities were placed at our disposal for the investigation. The factory is a thoroughly sanitary one, situated in a well-developed dairy region in the Central West.

PROCESS USED AT FACTORY

The packing stock is taken to the third floor, and after removal from containers is thrown into a large melting vat in the bottom of which are steam coils. One end of the vat is screened off, and in this screened-off section is a pump, constantly in operation during the melting process, conveying the melted mixture to a battery of settling tanks each having a capacity of 500 pounds.

The settling tanks are jacketed, the space between the jacket walls being filled with water which is heated with steam to maintain the proper temperature during the process of settling, which lasts from 6 to 10 hours. The clear butter oil is run from the settling tanks to the blowing tanks on the floor below. The blowing tanks also are jacketed, and have a capacity of 400 pounds of butter oil. The blowing is conducted at a temperature of from 110° to 120°F., about 15 hours being usually required for an average grade of packing stock. The air is washed and heated before coming into contact with the butter oil. The blown butter oil is passed over a continuous pasteurizer[2] held at 160°F., and is then ready to be emulsified. The emulsion is made in a circular tank provided with paddles or dashers revolving in opposite directions. The emulsion drops to the floor below into the crystallizing vat, and the crystals removed to the ripening room in trucks, each truck holding the contents of one blower. After ripening, the crystals are worked, salt added, and the finished product packed in cartons or tubs as may be demanded by the trade. It will be noted that this factory operates on what may be termed a unit system, the size of the unit being 500 pounds of finished renovated butter. From the time the packing stock is melted and placed in the settling tanks each unit is run by itself. For example, the contents of settling tank No. 1 go to blowing tank No. 1, and after being emulsified and crystallized is placed for ripening in truck No. 1. After ripening it is salted and worked by itself. This system enables a check to be held on each unit, and greatly simplified the investigational work.

PLAN OF INVESTIGATION

So far as the investigation is concerned, the packing stock for each day's run was of uniform quality. After melting, it was

[2] As a part of the regular procedure at this factory, the blown butter oil is passed over a continuous pasteurizer. Later in the paper the term "regular" is used to designate units which have been pasteurized in this way. This factory is one of few that subject the butter oil to the pasteurizing temperature at any stage of the process.

distributed among several settling tanks in conformity with the unit system of the factory. The units were allowed to settle at the same temperature for the same length of time and then run into the blowing tanks. Some of the units were blown at a temperature of from 110° to 120°F., others at 140°F., and still others at 160°F. In each case, the duration of blowing was governed entirely by the time required to "sweeten" the butter oil, a skilled operator being constantly on duty at the tanks during the blowing process. Some of the units blown at the lower temperature were subsequently passed over the continuous pasteurizer used for the regular product of the factory. From this point until it became a finished product, packed in pound cartons, each unit received, so far as it was possible to give it, identically the same treatment. The units blown at 110 to 120°F. are to be regarded as check units, and those blown at the higher temperatures as the pasteurized units.

The purpose in blowing some of the units at 160°F. was to learn the effect, upon the finished product, of a temperature considerably higher than is considered necessary for pasteurization.

Six 1-pound samples were taken from each unit. Three were immediately sent, in special containers by parcel post, to the scorers, and the other three sent in the same way to the cold-storage rooms.

COLD STORAGE

Since the scope of the investigation included the keeping quality of the finished product, the plan included the holding of the samples in cold storage for three weeks, this being considered as about the average time that renovated butter is kept in storage before it reaches the consumer. Some of the samples were kept in the cold storage rooms of a renovated-butter factory in Chicago, and the others in our own cold-storage rooms in Washington, the comparable samples being kept together in all cases. The temperatures of the storage rooms are not available, but it is considered that the samples were held under about the same conditions as is the average product from the time of its manufacture until consumed. At the end of three weeks the storage samples were scored.

SCORERS

The scorers selected for this work were men with years of experience in scoring renovated butter, and whose competency is unquestionable. The samples were sent to them labeled in such a way that they could not have known which had been pasteurized and which had not.

SYSTEM OF SCORING

The same system of scoring was used as with normal butter, with the exception that by agreement between the scorers, while

TABLE 1

Showing blowing temperatures, duration of blowing, and average scores of all units, when fresh and after storing

LOT NO.	UNIT NO.	TEMPERATURE BLOWN	HOURS BLOWN	AVERAGE SCORE FRESH*	AVERAGE SCORE STORED*	LOSS IN STORAGE
		deg. F.				
1	1	110–120†	15	87.83	86.33	1.50
1	2	Regular‡	15	89.50	86.00	3.50
1	3	140	2½	89.33	87.33	2.00
2	1	110–120†	14	88.33	86.17	2.16
2	2	160	2¾	88.50	87.83	0.67
2	3	140	4	88.67	87.00	1.67
2	4	Regular‡	15	89.17	87.50	1.67
3	1	160	4	87.67	87.00	0.67
3	2	140	4	88.50	87.00	1.50
3	3	Regular‡	15	88.00	86.83	1.17
4	1	140	4½	88.00	86.83	1.17
4	2	140	4½	88.67	87.50	1.17
4	3	140	4½	88.50	87.33	1.17
4	4	Regular‡	15	88.33	87.83	0.50
5	1	140	4	88.83	87.17	1.66
5	2	140	4	89.00	88.33	0.67
5	3	140	4	88.17	87.33	0.84
5	4	110–120†	15	88.67	88.00	0.67
5	5	Regular ‡	15	88.00	86.67	1.33

* Averages from scores of three scores.

† These units were not heated to the pasteurizing temperature at any stage of the process.

‡ These units were made in the regular way at this factory. They were blown at 110 to 120°F., and then run over a continuous pasteurizer.

TABLE 2

Showing scores by individual scorers

LOT NO.	UNIT NO.	TEMPERATURE BLOWN	SCORED BY MC'A.		SCORED BY L.		SCORED BY C.	
			Fresh	Stored	Fresh	Stored	Fresh	Stored
		deg. F.						
1	1	110–120*	88.50	86.50	88.00	88.50	87.00	84.00
1	2	Regular*	90.00	84.00	90.00	89.00	88.50	85.00
1	3	140	90.00	87.50	90.00	88.50	88.00	86.00
2	1	110–120*	89.00	83.50	88.00	89.00	88.00	86.00
2	2	160	88.50	88.00	89.00	88.50	88.00	87.00
2	3	140	88.50	87.50	89.50	89.50	88.00	84.00
2	4	Regular*	89.00	86.50	90.00	90.00	88.50	86.00
3	1	160	87.00	87.00	88.00	88.00	88.00	86.00
3	2	140	89.50	86.00	88.00	88.00	88.00	87.00
3	3	Regular*	87.50	86.00	89.50	88.50	87.00	86.00
4	1	140	88.00	87.00	88.00	88.50	88.00	85.00
4	2	140	88.00	87.70	89.50	89.00	88.50	86.00
4	3	140	87.00	86.00	90.00	89.00	88.50	87.00
4	4	Regular*	87.50	87.00	88.50	89.50	89.00	87.00
5	1	140	88.00	86.50	90.00	90.00	88.50	85.00
5	2	140	89.00	87.00	90.00	90.00	88.00	88.00
5	3	140	88.00	88.00	88.50	89.00	88.00	85.00
5	4	110–120*	88.00	87.00	88.50	88.00	89.00	89.00
5	5	Regular*	87.00	86.50	88.50	88.50	88.50	85.00

* See notes under table. 1

TABLE 3

Showing individual and average scores of units taken in groups

SCORERS	110-120°F.			REGULAR			140°F.			160°F.		
	Fresh	Stored	Loss	Fresh	Stored	Loss	Fresh	Stored	Loss	Fresh	Stored	Loss
McA	88.67	85.67	3.00	88.20	86.00	2.20	88.41	87.00	1.44	87.75	87.50	0.25
L	88.17	88.50	−0.33	89.30	89.10	0.20	89.28	89.06	0.22	88.50	88.25	0.25
C	88.00	86.33	1.67	88.30	85.80	2.50	88.17	85.89	2.28	88.00	86.50	1.50
Average	88.28	86.83	1.45	88.90	86.97	1.93	88.93	87.32	1.61	88.08	87.42	0.66

Grand average of all units when fresh 88.55
Grand average of all units after three weeks in storage 87.14
Loss 1.41

100 is the perfect score for normal butter, 90 was considered as the highest score to be given renovated butter. In other words, a renovated butter scoring 90 is to be considered as perfect in flavor, grain, salt, color, and condition of package for that class of product.

DISCUSSION OF RESULTS

In studying the tables it should be borne in mind that fractions of scores mean very little. The human senses, even when highly trained, are not sufficiently sensitive to detect such small differences with exactness. Two experienced butter scorers working independently can not always be expected to agree within a point on an arbitrary scale. They can, however; be depended upon to detect very slight differences in flavor or grain in different samples of any given lot of butter.

In this investigation the comparable samples were subjected to the same conditions of transporation, etc. This is not true, however, of the samples sent to the different scorers. The work was done in May and June during a period of rather warm weather. The samples were sent through the open mails with, of course, no attempt at refrigeration. The samples received by scorers McA. and C. were sent from the Central West to Washington and to a place in New York State, while those received by L. were sent to Chicago, only a few miles from where they were manufactured. It will be evident that while the different samples comprising a given lot received by any one scorer are comparable, the corresponding samples received by the different scores are not strictly so, since they were under different conditions of transit.

In examining the individual scores it will be observed that in eight instances the units were given perfect scores. In three of these cases the units had been made by the regular method of the factory, that is, by blowing the butter oil at from 110° to 120°F., and then passing it over a continuous pasteurizer, and in five cases the units had been made from butter oil blown at 140°F. Eighty-seven was the lowest score given any fresh unit. This was given in five cases; two regular units, one where the

butter oil had been blown at 110° to 120°F., one where it had been blown at 140°F., and one at 160°F. Three stored units were given perfect scores, two in which the butter oil had been blown at 140°F., and one regular. Eighty-three and a half and eighty-four were the lowest scores given stored units. These scores were given in four cases, two where the butter oil had been blown at 110° to 120°F., one at 140°F., and one regular. It will be seen from these individual scores that there is practically no difference between the units blown at the different temperatures. This is brought out even more clearly in table 3, which gives the average scores for the units taken in groups.

A striking point brought out in table 1 is the great reduction in time effected by blowing at the higher temperatures. It will be noted that it took but from two and one-half to four and one-half hours to "sweeten" the butter oil blown at the higher temperatures, while about fifteen hours were required to bring it to the same condition when blown at the lower temperature. This fact should be of value to renovated butter makers, inasmuch as it not only enables them to pasteurize their butter oil, but at the same time reduces by two-thirds or more the time of blowing, and should correspondingly reduce the cost of this phase of the renovating process. It may be of especial interest to the smaller plants which do not run continuously, since by employing the pasteurizing temperature the blowing can be completed in the day.

Somewhat closer attention is required from the operator when blowing at the higher temperatures, since the margin of time between the point when the butter oil "sweetens" and when it becomes "overblown" is shorter than with the low temperature. This should not, however, prove a serious objection.

SUMMARY

Renovated butter was made from a uniform grade of packing stock under factory conditions. The details of manufacture, except the blowing temperatures, were held as nearly alike as possible. Part was blown at the pasteurizing temperature, and

the rest at the usual temperature. Samples were scored while fresh, and after holding three weeks in cold storage. No differences were found that could be ascribed to the blowing temperatures.

From two and one-half to four and one-half hours were required to "sweeten" the butter oil at the pasteurizing temperature, while about fifteen hours were required to bring the butter oil blown at the usual temperature to the same condition, thus cutting down two-thirds of the operating time of this phase of the process.

CONCLUSIONS

The results of the investigation indicate that the butter oil may be blown at a temperature that will insure its pasteurization without impairing in any way the flavor, grain, or keeping quality of the finished product.

BUTTER SHRINKAGE

E. S. GUTHRIE

Ithaca, New York

Cornell University completed the storage of 100 tubs of butter on July 9, 1916. This butter was made in eight different churnings from sweet, pasteurized cream. The body was good, the moisture was nicely incorporated. All the butter was overworked somewhat, which had a tendency to pretty complete incorporation of the water. The moisture and salt analysis were as follows for the eight churnings.

CHURNING	DATE	MOISTURE	SALT
		per cent	*per cent*
I	June 23	15.4	3.1
II	June 24	14.9	2.5
III	June 25	15.5	2.5
IV	June 26	14.6	2.9
V	July 5	15.3	2.9
VI	July 1	15.1	2.8
VII	July 8	15.7	2.1
VIII	July 9	15.1	3.1

The tubs were paraffined. They were weighed just a few minutes before the butter was packed in them. Thus there was little shrinkage of the tub from the time that it was weighed until it was filled. The weighing was done on scales that weighed in terms of pounds and ounces. The same scales were used in all weighings.

The butter was weighed on November 20, after being in cold storage for 134 days at 0° to −10°F. The shrinkage or increase in weight is noted in the following table.

Seventeen packages showed an increase in weight ranging from 0.5 ounce to 27.5 ounces. Eighty three tubs showed shrinkage which varied from 0.5 ounce to 15.5 ounces. The total shrinkage was 377.5 ounces. The total increase weight was

TUB NO.	DECREASE OR INCREASE	TUB NO.	DECREASE OR INCREASE	TUB NO.	DECREASE OR INCREASE	TUB NO.	DECREASE OR INCREASE
			Churning I				
	ounces		ounces		ounces		ounces
1	− 3.5	5	+27.5	8	− 3.5	11	− 3.5
2	− 1.5	6	− 1.5	9	− 3.5	12	− 1.5
3	+10.5	7	+ 3.5	10	− 9.5	13	− 7.5
4	− 4.5						
			Churning II				
14	−10.5	18	− 8.5	21	− 2.5	24	− 4.5
15	− 7.5	19	− 6.5	22	− 7.5	25	− 7.5
16	− 6.5	20	−13.5	23	− 7.5	26	− 6.5
17	− 7.5						
			Churning III				
27	− 0.5	31	+ 3.5	35	+ 0.5	39	− 2.5
28	+ 3.5	32	− 1.5	36	− 4.5	40	+ 8.5
29	+ 1.5	33	− 2.5	37	− 2.5	41	− 3.5
30	− 2.5	34	− 0.5	38	− 0.5		
			Churning IV				
42	− 0.5	46	− 3.5	49	+ 4.0	52	− 5.5
43	− 1.5	47	− 2.5	50	+ 1.5	53	− 2.5
44	+ 1.5	48	− 4.5	51	−15.5	54	+ 5.5
45	− 4.5						
			Churning V				
55	− 1.5	59	− 1.5	63	− 8.5	66	− 3.5
56	− 3.5	60	+ 0.5	64	− 3.5	67	− 2.5
57	+ 9.5	61	− 1.5	65	− 0.5	68	− 1.5
58	− 5.5	62	− 4.5				
			Churning VI				
69	− 3.5	73	− 5.5	76	− 1.5	79	− 2.5
70	− 8.5	74	− 7.5	77	− 3.5	80	+ 1.5
71	− 0.5	75	− 4.5	78	− 3.5	81	− 5.5
72	− 0.5						
			Churning VII				
82	− 2.5	85	− 5.5	88	− 7.5	90	− 6.5
83	− 5.5	86	− 6.5	89	− 4.5	91	− 6.5
84	− 5.5	87	− 3.5				
			Churning VIII				
92	− 5.5	95	− 4.5	97	− 6.5	99	− 1.5
93	− 9.5	96	− 5.5	98	− 3.5	100	+ 0.5
94	− 5.5						

85 ounces. The net shrinkage was 292.5 ounces or 18.28 pounds which is 0.1828 pound for tub or 0.29 per cent.

The writer cannot account for some of the extreme weights. It looks very much as though it was error in weighing. If the work is continued this summer, provision will be made for check weighing.

AGE AT FIRST CALVING

G. C. WHITE

Storrs, Connecticut

The most desirable age for the first parturition with cows is a very important question. In a great many herds it is certain that the method of raising heifers is not such as to permit full development of their inherited powers of production. Prof. F. W. Woll in Research Bulletin No. 26 of the Wisconsin Experiment Station, and others, have shown positively that the large cows of any breed are capable of higher and more profitable production. It is the extra capacity that a large animal has that counts, providing they are equal in other respects.

For a good many years the belief was rife among breeders that it was necessary to have cows calve early in order to stamp upon them dairy qualities rather than tendencies for beef production. Some discovered from their own experience that this was erroneous, but these men were really in the minority. It was also commonly believed that heifers should not be allowed to become fat before calving and that they must get their nutrients for the most part from roughages. Dr. C. H. Eckles in Bulletin No. 135 of the Missouri Experiment Station shows that getting heifers fat affects the dairy qualities very little if at all and that those raised for the most part upon concentrates were equally as capable of consuming a dairy ration after calving as those raised on roughages, when each had become adjusted to the ration. Many Holstein breeders in preparing heifers for large records have learned to fear no injury to the dairy qualities by liberal feeding; with breeds where refinement of body is sought too much development before calving may, however, be detrimental.

The subject of this paper makes reference to the age at first calving. The age aside from the cost of raising heifers is in reality of little consequence at all. The thing of great importance is that they should be big, strong heifers and the procedure may

TA

COW NO.	NAME	WEIGHT	SIRE	BORN	FIRST LACTATION				SECOND LACTATION			
					Age	Milk	Fat	Length	Age	Milk	Fat	Length
								days				days
1	Fay M 2d	1,400	Hubbard Netherland De Kol	10/31/05	2–3	7,803	273	340	3–2	9,683	312	365
2	De Kol Hubbard Pietertje	1,400	Hubbard Netherland De Kol	4/27/06	2–7	8,004	292	283	3–4	11,073	380	365
3	De Kol Hubbard Pietertje 2d	1,350	Minnie Hark Prince Korndyke	10/20/08	2–0	8,124	321	365	3–3	9,686	371	365
4	Fay De Kol Burke 4th	1,250	Minnie Hark Prince Korndyke	12/22/08	2–1	7,048	232	245	—	—	—	—
5	Fay M 2d Minnie Hark	1,350	Minnie Hark Prince Korndyke	1/ 5/09	1–11	7,059	226	365	—	—	—	—
6	Pietertje De Kol Burke 2d	1,500	Sir Inka De Kol Lilith	9/ 6/10	3–4	18,850	661	365	4–7	16,308	529	365
7	Storrs Pietertje	1,275	Sir Hubbard Pietertje	11/11/10	3–0	10,642	376	3754	–5	11,723	377	365
8	Minnie Fay Pietertje	1,350	Sir Hubbard Pietertje	12/16/10	3–6	17,020	525	365	4–9	20,823	607	365
9	Minnie Hubbard De Kol	1,175	Minnie Hark Pietertje Burke	2/ 8/12	2–4	8,420	315	365	4–0	6,663	252	265
10	Fay Burke Pietertje	1,325	Minnie Hark Pietertje Burke	12/ 7/12	3–0	11,125	359	365	4–2	2/23/17†		
11	Minnie Fay De Kol	1,225	Minnie Hark Pietertje Burke	2/17/13	3–6	3,446	128	156*				
12	Dorinda Storrs De Kol	1,100	King Segis Inka Fayne	2/11/14	2–6	6,648	225	169†				

— Indicates incomplete gestation.
* Still milking.
† Still milking well in this lactation.
‡ Has milked over 70 pounds per day this period.
§ Lost quarter through injury.
** Still milking well in this lactation.
†† Still milking well in this lactation.
‡‡ Still milking well in this lactation.
§§ Still milking well in this lactation.
° Has milked over 10,000 pounds in 6 months.

BLE 1

THIRD LACTATION				FOURTH LACTATION				FIFTH LACTATION				SIXTH LACTATION				SEVENTH LACTATION			
Age	Milk	Fat	Length	Age	Milk	Fat	Length	Age	Milk	Fat	Length	Age	Milk	Fat	Length	Age	Milk	Fat	Length
			days				*days*				*days*				*days*				*days*
5–5	10,882	350	365	7–2	12,593	353	316	8–2	15,302	455	351	9–3	15,140	433	358	10–4	11,842	343	304
4–8	14,236	520	365	6–9	23,176	831	365	8–6	(Died)										
5–3	18,206	718	365	6–6	13,481	511	365	7–10	9,839	351	142††								
4–2	12,655	434	343	—	—	—	—	6–6	13,431	466	365	8–0	6,904	220	134§§				
4–6	12,467	366	365	5–11	16,067	495	364	7–0	15,041	488	328	8–1	(2/27/17						
5–10	7,711	246	205**																
5–11	4,130	167	135††																
6–1	(1/30/17)°																		
—	—	—	—																

depend upon conditions. If concentrates are used liberally the rapid development will permit of earlier breeding. If the use of concentrates is limited the first calving period should be somewhat postponed.

In general practice, the dairy cows must pay the bills and this is a primary consideration. Roughages, so far as possible, must, therefore, be made use of, and heifers must calve so that returns will commence to come in. The aim of this paper is to present production records from the Connecticut Agricultural College Holstein herd which throw some light upon the question as to how to get the most capable animal.

The preceding tabulation gives the information concerning the registered cows at present in the herd that are in milk.

The table gives the name and sire of each one, the age at each calving and the amount of milk and fat produced in each lactation period, together with the length of such period. The production in excess of 365 days is not included, and the records during the period following incomplete gestations are omitted.

It will be noticed that the age of first calving varies from 1 year and 11 months to 3 years and 6 months. The ages that exceed thirty-six months have not purposely been arranged, but have resulted from failure to conceive promptly. The writer is not certain but that this has been a "blessing." Dr. Eckles in the bulletin above referred to pointed out that there seemed to be no advantage from having Holstein cows calve much later than thirty months, although he remarked that this would depend upon their stage of development. Our heifers are kept in thrifty condition and are fed skimmed milk with a grain supplement until six to eight months of age. After this, when not on pasture, they receive 3 to 6 pounds of grain, together with hay and silage daily to keep them growing well.

These cows are divided into two groups: those calving at thirty months or less and those calving at an age above thirty months. The average production of each group is given in tables 2 and 3.

Only ten are included in these tables because the other two have not completed a year or a lactation period. There are five in each group and the two remaining occur one in each division.

The average age of the early calvers is 2 years and 1.4 months and of the late calvers 3 years and 1 month, practically one year later. The production for the first period is 7691 pounds milk and 273 pounds fat in an average milking period of 356 days against 13,128 pounds milk and 443 pounds fat in 349 days

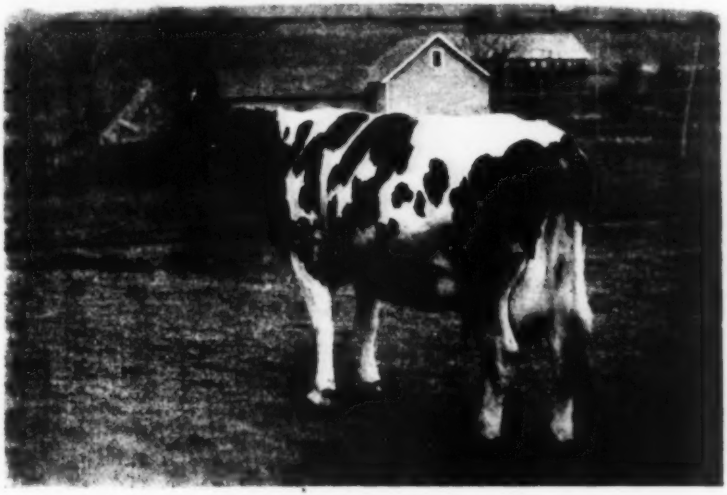

FIG. 1. FAY M. 2D MINNIE HARK

She shows here to her finest advantage. She is a little light in the middle and has a poorly developed fore udder. When taken she was heavy with fifth calf. She calved at 1 year 11 months. Best production 16,067 pounds milk and 495 pounds fat in her fourth lactation.

which is nearly double the early calvers. One of the late calvers milked only 283 days.

In the second period only two of the early calvers are included. Two others (nos. 4 and 5) aborted and another (no. 9) lost one-quarter due to an injury and her record was thrown out. Of the two included one is the best cow in this lot and the other is equal to the others. This year the average milk was 9684

pounds and the fat 342 pounds in 365 days. Only four of the late calvers have finished the second lactation and their average is 14,682 pounds of milk and 473 pounds of fat in 365 days. The fifth (no. 10) has recently freshened and has milked over 70 pounds in a day in her second period. The average age of

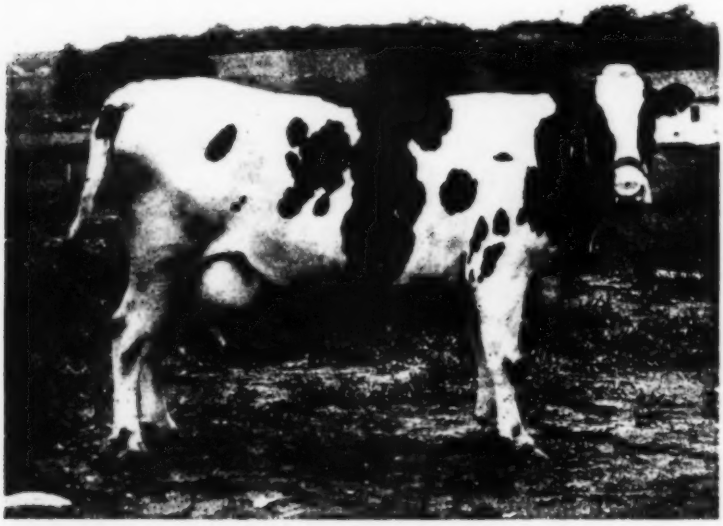

FIG. 2. PIETERJE DEKOL BURKE 2D

A large well developed cow weighing 1500 pounds. She weighed 1400 with her first calf and calved at 3 years 4 months. She produced 18,850 pounds of milk and 661 pounds of fat with her first calf which placed her fifth at the time in her class of world's records. She is feminine and a striking Holstein type.

freshening was 3 years 2.5 months and 4 years 5 months respectively for the two groups.

In the third period four of the early calvers have completed a record. Their average is 13,552 pounds of milk and 467 pounds of fat in 360 days. The average age of freshening is 4 years 9.5 months. Their production for this year is approximately equal to the first year of the late calvers. Their total average

production for three lactations is only 3000 pounds greater than the total average production of the late calvers in two lactations. Their age at the third calving is 4 years 9.5 months against 4 years and 5 months, the average age at 2nd calving of the late calvers. Only one of the late calvers (no. 2) has finished the third lactation period; she produced 14,236 pounds of milk and

TABLE 2

Early calvers. Cows calving thirty months or under

COW NO.	AGE FIRST CALVING	FIRST PERIOD			SECOND PERIOD			THIRD PERIOD		
		Milk	Fat	Days	Milk	Fat	Days	Milk	Fat	Days
1	2–3	7,803	273	340	9,683	312	365	10,882	350	365
3	2–0	8,124	321	365	9,686	371	365	18,206	718	365
4	2–1	7,048	232	345	—	—	—	12,655	434	343
5	1–11	7,059	226	365	—	—	—	12,467	366	365
9	2–4	8,420	315	365	—	—	—			
Total.....	10–7	38,454	1,367	1,780	19,369	683	730	54,210	1,868	1,438
Average.....	2–1¾	7,691	273	356	9,684	342	365	13,552	467	360

TABLE 3

Late calvers. Cows calving at age over thirty months

COW NO.	AGE FIRST CALVING	FIRST PERIOD			SECOND PERIOD			THIRD PERIOD		
		Milk	Fat	Days	Milk	Fat	Days	Milk	Fat	Days
2	2–7	8,004	292	283	11,073	380	365	14,236	520	365
6	3–4	18,850	661	365	16,308	529	365			
7	3–0	10,642	376	365	11,723	377	365			
8	3–6	17,020	525	365	20,823	607	365			
10	3–0	11,125	359	365						
Total.....	15–5	65,641	2,213	1,743	59,927	1,893	1,460	14,236	520	365
Average.....	3–1	13,128	443	349	14,682	473	365	14,236	520	365

520 pounds of fat in 365 days. Number 6 will produce around 12,000 pounds of milk, no. 7 about the same and no. 8 is starting off at better than a 15,000 pound rate. In her fourth lactation period no. 2 produced 23,176 pounds of milk.

Just how much individuality, breeding, and management have to do with these yields it is impossible to say. All have

descended from the same family lines in the herd and two of the sires, Sir Hubbard Pietertje and Minnie Hark Pietertje Burke are out of cows that were bred in the herd. Among the late calvers Minnie Fay De Kol has not completed a record, but she is the only one to be a low producer. Due to an ill-formed udder she is considered a failure and will be discarded, but she is not lacking in feminine qualities and is a good sized cow for her age. Number 12 is the only one in the early calvers that has not completed a record. She calved at 2 years 6 months and is an unusually good heifer that would be good for 18,000 if she had the scale and development possessed by the late calvers in their first period. As it is, she should come close to 12,000 pounds of milk. As to management, there is no doubt but that the herd has been under somewhat more intensive working conditions for the past five years, but numbers 1, 3, 4 and 5 of the early calvers have reached their limit while in the writer's opinion nos. 6 and 10 will join nos. 2 and 8 (all late calvers) in the 20,000 pounds division. Whether no. 7 will do this is problematical. Number 12 of the early calvers will be expected to do so, but to insure proper development she will be given a long dry period this year.

Only one cow among the late calvers would be criticised for lack of refinement, or feminity. This one, no. 8, has a steerish head. All of them appeared somewhat lacking in dairy form until they became advanced in the gestation period, and especially after calving they rapidly assumed a dairy conformation. Number 6 the largest one in the lot is typically Holstein and decidedly feminine. Numbers 3, 4, 5 and 9 of the early calvers, while good cows are all somewhat smaller than the others and lack in that splendid size and capacity shown early by the other group.

For various reasons it is becoming more and more important for dairymen to get the most efficient production from their herds. In herds of doubtful dairy qualities, there is good reason to have cows calve early to find as soon as possible if they are worth having in the herd. In a herd where dairy qualities are of medium to high order, more attention should be given to the

full development of the heifers in size and capacity for efficient and profitable production.

Would it not be well for other experiment stations to present any data they have along this line through the columns of this organ?

REPORT OF COMMITTEE ON CHANGE OF NAME

At the Springfield meeting of the Official Dairy Instructors' Association, exception was taken to the name of the Association because the word "Official" suggested police activities and the word "Instructor" seemed to limit the membership unduly.

After some discussion the following action was taken:

It was moved and seconded that the change of the name of the Association be left to the President, Secretary, and Professor Harding, but before a name be adopted a vote of the membership be made.

The first step of the Committee was to solicit suggestions from various members of the Society as to what seemed most desirable in the way of a Society name. These suggestions were then submitted to the entire membership with the request that the first, second, and third choice of each member be returned to the committee upon an enclosed postal card. The date set for the closing of the ballot was March 15. The results of this ballot are given below:

Relation of votes on future name of Official Dairy Instructors' Association

	FIRST	SECOND	THIRD	VALUE
American Dairy Instructors' Association	11	12	8	19⅔
American Association of Dairy Instructors	10	4	9	15
Association of American Dairy Instructors	0	4	4	3⅓
Society of American Dairy Instructors	7	4	7	12⅓
American Society of Dairy Instructors	2	11	11	11⅓
American Association for the Promotion of Dairy Research and Instruction	7	10	17	17⅔
Society of American Industry	1	4	2	3⅔
American Society of Dairy Industry	9	16	3	18
American Association of Dairymen	0	7	3	4⅓
American Dairy Science Association	32	10	14	41⅔
Scattering	8	2	2	9⅔

It will be noted from the above table that the "American Dairy Science Association" was by far the predominating first

choice of the members voting. In attempting to give proper valuation to the second and third choice of each member, it seemed best to consider that two second and three third choices had the same weight as the one first choice. The table, accordingly, shows the values of the vote computed upon this basis. It will be noted, that upon this basis, also, the vote for the "American Dairy Science Association" name is very much in the lead.

As the result of the action of the Society at its last meeting, and as the result of the vote which has just been taken, the "Official Dairy Instructors' Association" has now become the "American Dairy Science Association."

Respectfully submitted,

(Signed) H. A. HARDING.

Approved:

W. A. STOCKING, *President.*

M. MORTENSEN, *Secretary.*

REPORT OF THE COMMITTEE ON METHODS OF CONDUCTING THE STUDENTS' NATIONAL CONTEST IN JUDGING DAIRY CATTLE

HELMER RABILD, H. H. WING, H. H. KILDEE, J. A. McLEAN, E. G WOODWARD AND WILLIAM REGAN

The Students' National Contest in Judging Dairy Cattle has been held each year since 1908, with the exception of the year 1915, when there was no National Dairy Show. Beginning with 1908 and ending with 1916, 97 teams and 2 individuals, making a total of 293 students, representing 25 agricultural colleges, have participated in the various contests. The following table shows which colleges have competed in each of the contests.

Iowa, Missouri, Nebraska, New York, and Ohio have competed in all the contests.

Since the contest was first established, the various dairy breeders' associations whose cattle were judged, together with Hoard's Dairyman, the National Dairy Show Association, and the J. B. Ford Company, have demonstrated their willingness to promote the contest by awarding trophies in the form of silver cups to the winning teams.

The various dairy breeders' associations have given cups to the teams that have won the highest scores in judging their respective breeds. The National Dairy Show Association and Hoard's Dairyman award their cups to the sweepstakes teams. The Wyandotte cup is offered by the J. B. Ford Company, manufactures of the Wyandotte Dairyman's Cleaner and Cleanser, to the team receiving the second highest total score in judging all classes.

A sweepstakes prize of $50 was awarded by the National Dairy Show in 1908, 1909, and 1910 to the man who received the highest individual score in judging all classes. The William Howard Taft cup, offered in 1911, was awarded to the man who made the highest individual score in judging all classes. In 1912

Colleges participating in judging contests

1908	1909	1910	1911	1912	1913	1914	1916	NUMBER OF CONTESTS PARTICIPATED IN BEFORE 1917
Iowa	Iowa	Iowa	Iowa	Iowa	Iowa	Iowa	Iowa	8
Mo.	Mo.	Mo.	Mo.	Mo.	Mo.	Mo.	Mo.	8
Neb.	Neb.	Neb.	Neb.	Neb.	Neb.	Neb.	Neb.	8
N. Y.	N. Y.	N. Y.	N. Y.	N. Y.	N. Y.	N. Y.	N. Y.	8
Ohio	Ohio	Ohio	Ohio	Ohio	Ohio	Ohio	Ohio	8
Kan.			Kan.	Kan.	Kan.	Kan.	Kan.	6
		Ky.	Ky.	Ky.	Ky.	Ky.		5
S. Dak.			S. Dak.	S. Dak.	S. Dak.	S. Dak.	S. Dak.	6
	Penn.			Penn.	Penn.	Penn.	Penn.	5
		N. H.		N. H.	N. H.	N. H.	N. H.	5
			Del.	Del.	Del.	Del.	Del.	5
			Md.	Md.	Md.	Md.	Md.	5
				Mass.	Mass.	Mass.	Mass.	4
					Maine	Maine	Maine	3
Minn.	Minn.	(Minn.)*						2
				Mich.	Mich.			2
Texas								1
					Va.			1
						Ark.		1
						Ore.		1
							Conn.	1
							N. J.	1
							N. C.	1
							R. I.	1
							Vt.	1
9	7	7	10	14	16	16	18	97

* One member of team withdrew from team, and the remaining two competed as individuals.

and 1913 the sweepstakes prizes consisted of scholarships, given by the De Laval Separator Company and the Blue Valley Creamery Company to the two best men. In each of the two years 1914 and 1916 the National Dairy Show awarded five gold medals to the five highest men in judging all breeds, and the De Laval scholarship went to the highest. In 1914 and 1916 the Iowa Dairy Separator scholarship was awarded to the institution sending the sweepstakes team.

The following table indicates in detail the trophies offered each year, and the winners of these trophies:

Winners of trophies

	1908	1909	1910	1911	1912	1913	1914	1916
National Dairy Show cup	Iowa	Nebr.	N. Y.	Ky.	Nebr.	Mo.	Ohio	Nebr.
Hoard's Dairyman cup	Iowa	Nebr.	N. Y.	Ky.	Nebr.	Mo.	Ohio	Nebr.
Jersey cup	Nebr.	N. Y.	N. Y.	Md.	Mo.	Iowa	Ohio	Mass.
Guernsey cup	Iowa	Minn.	N. Y.	Ky.	Mass.	Pa.	Ark.	Kan.
Holstein cup	N. Y.	Nebr.	Ohio	Ky.	Neb.	Mo.	Maine	Nebr.
Ayrshire cup		Ohio					Kan.	N. H.
Dutch Belted cup	Iowa	Mo.						
President Taft cup				S. Dak. Russell Jensen,				
Wyandotte cup							Kan.	Mass.

National Dairy Show sweepstakes prize:

1908.....F. D. Hawk, Iowa
1909.....Will Forbes, Nebraska
1910.....T. B. McNatt, Missouri

Gold medals:

1914.....Rob. Wylie, Ohio; P. E. Richards, Kentucky; C. E. Wylie, Ohio; V. F. Stuewe, Kansas; and G. G. Davis, Missouri.
1916.....H. H. Hawes, Rhode Island; W. L. Henderson, Iowa; F. W. Fitch, New Hampshire; E. M. Harmon, Missouri; and C. R. Snyder, Nebraska.

A total of 48 cups have been offered, of which the following colleges have won two or more:

Nebraska	10	Missouri	5	Kansas	3
New York	6	Ohio	5	Massachusetts	3
Iowa	5	Kentucky	4		

Beginning with the 1910 contest, the sum of $8400 has been awarded to students who competed in the contest, or to colleges represented in the contest to be reawarded to worthy students of those institutions. Of this sum, $5800 has been paid or is in process of payment, while $1000 has reverted to the donors. The sum of $1600 remains to be paid to the four students who were winners in the 1916 contest.

This prize money has enabled eleven students to complete each one year of postgraduate work in dairying, three students to begin their postgraduate courses during the present school year, and four others to begin their postgraduate courses upon graduation. Another student completed one half-year of advanced work in dairying.

The following associations and companies have donated, scholarships:

1. Holstein-Friesian Association of America.
2. American Jersey Cattle Club.
3. Blue Valley Creamery Company, of Chicago, Illinois manufacturers of Blue Valley butter.
4. De Laval Separator Company, of Chicago, Illinois, manufacturers of the De Laval cream separator.
5. Associated Manufacturers Company, of Waterloo, Iowa, manufacturers of the Iowa dairy separator.

The disposition of the scholarship money is indicated in detail in the following outline.

Mr. T. B. McNatt, since completing his course, has been connected with private dairy interests in and near Memphis, Tennessee.

Mr. Ivan McKellip is employed in dairy-extension work in Ohio by the Dairy Division, U. S. Department of Agriculture, in coöperation with the Ohio State University.

Mr. Karl B. Musser is employed in dairy-extension work in Connecticut, by the Dairy Division of the U. S. Department of Agriculture, in coöperation with the Storrs Agricultural College.

Mr. A. C. Stanton is an instructor in dairy husbandry at the Maryland Agricultural College.

Mr. Russell Jensen conducts the Progressive Dairy Depot at Watertown, South Dakota. Mr. Jensen is a dealer in milk, cream, butter, and wholesale ice cream.

Mr. C. L. Burlingham recently resigned from a position with the Dairy Division, U. S. Department of Agriculture, to become associate editor of the Hoard's Dairyman, Fort Atkinson, Wisconsin.

Mr. Omar I. Oshel was employed by the Dairy Division, U. S.

Outline of scholarships

YEAR	SCHOLARSHIP	WINNER	STATE	CLASS	POST-GRADUATE COURSE TAKEN AT	YEAR OF POST-GRADUATE COURSE
1910	Holstein	T. B. McNatt	Mo.	1911	Cornell	1911–12
	Jersey	Ivan McKellip	Nebr.	1911	Cornell	1911–12
1911	Holstein	Karl B. Musser	Kan.	1912	Missouri	1912–13
	Jersey	A. C. Stanton	Md.	1912	Missouri	1912–13
	Blue Valley	Russell Jensen	S. Dak.	1912	Missouri	1912–13
1912	Holstein	C. L. Burlingham	Iowa	1913	Missouri	1913–14
	Jersey	Omar I. Oshel	Kan.	1914	Missouri	1915–15
	Blue Valley	S. H. Whisenand	Nebr.	1915	Died†	
	De Laval	H. C. Heaten	Mo.	1914	Forfeited†	
1913	Holstein	L. W. Wing*	Mo.	1915	Cornell	1915–16
	Jersey	W. W. Swett	N. H.	1915	Missouri	1915–16
	Blue Valley	W. A. Rhea	Mo.	1915	Cornell	1915–16
	De Laval	L. G. Mulholland	Del.	1916	Wisconsin	1916–17
1914	Holstein	C. L. Blackman	Maine	1916	Iowa	1916–17
	Jersey	M. H. Keeney	Pa.	1915	Missouri	1916–17
	De Laval	Robert Wylie	Ohio	1915	Missouri	1915–16
	Iowa Dy. Sep.	C. Elmer Wylie	Ohio	1915	Missouri	1915–16
1916	Holstein	W. F. Roberts	Nebr.			
	Jersey	C. H. Clough	Mass.			
	De Laval	H. H. Hawes	R. I.			
	Iowa Dy. Sep.	Nebraska team	Nebr.			

* Surrendered half of scholarship when he discontinued work at Cornell at the end of the first semester.

† The Blue Valley and De Laval scholarships offered in 1912 were not used by the winners and the money reverted to the donors.

Department of Agriculture, in coöperation with Purdue University to do extension work in dairying in Indiana. Mr. Oshel resigned from this position August 1, 1916, to begin work on his own farm in Kansas.

Mr. W. W. Swett is an instructor in dairying at the University of Missouri.

Mr. W. A. Rhea is an instructor in dairying at the College of Agriculture of the West Virginia University.

Mr. L. G. Mulholland, Mr. C. L. Blackman, and Mr. M. H. Keeney are at present pursuing their postgraduate studies.

Mr. Robert Wylie is an instructor in dairying at the Iowa State College.

Mr. C. Elmer Wylie is an instructor in dairying at the University of Tennessee.

As the contest has grown in popularity and influence there has been a corresponding change in the methods of conducting it. Some of these changes have been developed to meet new conditions, and others have been developed to better meet the conditions that have existed in all the contests. Your committee on method of conducting the judging contest has been very grateful to receive criticisms and suggestions from so large a number of instructors in animal and dairy husbandry in the agricultural colleges. While many of your suggestions have been incorporated into the rules in some form, there may be some among you who find that their ideas have not been incorporated. Your committee has given very through consideration to every letter it has received, and the ideas expressed have been incorporated into the proposed rules so far as possible. In cases in which it was found impossible to use the idea, an attempt has been made to explain to the writer the reason why it was not incorporated. That the contest has greatly improved we believe to be beyond question, yet we realize that it is still far from perfect, and we earnestly solicit your continued coöperation and mutual helpfulness to promote the contest from year to year.

In 1908 there was one official judge for each breed. It was the duty of this judge to make the official placing of each class in his own breed, and to grade the contestants' placings and reasons for placing. When a class of animals was brought into the ring the judge looked it over, made his decision regarding the animals, and then retired to the judging room. After examining the class the contestants reported to the judge one by one, to be graded. The reasons were given orally. The animals to be judged were selected by the general superintendent of the livestock department.

In 1909 the rules provided that while the animals were ex-

amined by the contestants the animals should be walked at least three minutes so as to enable the contestants to see them in motion. The animals were selected by the superintendent of the contest instead of by the superintendent of the live-stock department.

In 1910 the judging committee consisted of three men, who made the official placing of all classes and graded the contestants' placings and reasons. These judges scored the animals in each class, using the score card prescribed by the breeders' association of each breed. The official placing of a class was determined by the averages of the scores for each animal. After a group of contestants had examined a class of animals they recorded the placings and made notes regarding the animals. After examining two groups they were conducted into a room where they wrote their reasons for placing.

The placing of the animals was graded by the judges' clerk, according to a table prepared before the contest. This table provided a cut of ten points for each place that the animal was out of place. In grading reasons the clerk read the contestants' papers to the three judges. The average of the three grades made by the judges was assigned to the contestant as his grade on reasons.

In all contests previous to 1911, ties between contestants, if they existed, were broken by finding who had obtained the highest rating in judging bulls. The rules since 1911 have provided that ties should be broken by finding who had obtained the highest rating in judging cows.

The deduction for placing an animal one place too low or one place too high was made 15 points instead of 10 points.

The rules governing the 1912 judging contest were not materially different from those governing the contest in 1911.

In 1913, the judging committee consisted of one man from each institution having a team in the contest. This man was the coach of the team. The committee collectively decided the official placing of the animals in each class, and graded the contestants' reasons for placing. One of the reasons for changing the composition of the judging committee was the great difficulty

in securing a committee of three men upon whom all could agree. Even when this had been accomplished it was necessary to make substitutions because some of the men selected had already been engaged as judges of the Show or because they refused to serve. It was also believed by many of the instructors that while the expert judges were well qualified to place the animals properly, yet they were not in all cases well qualified to grade the students' reasons. The chief reason, however, was the belief that with the instructors placing the animals and grading the reasons, the judging of dairy cattle would be materially standardized in the agricultural colleges.

On the basis of the experience in 1913 it was found advisable to modify the rules for 1914 so as to provide that the committee of judges should be divided into four groups, each group to hear and grade all the reasons of two classes, one of cows and one of bulls, both of the same breed. The rules were further amended to make a cut of 5 to 10 points instead of 15 for switching a pair of animals within a class that had been agreed by the judging committee were close. Whether 5 or 10 points were cut depended upon the degree of the closeness.

Early in 1915 a very thorough analysis was made of the methods and results of the 1914 contest. The main difficulty of this contest as learned in the analysis, was that there was little uniformity in the reasons for placing and that on account of the variation it was practically impossible for the judges to give a just rating on the papers. It was at first believed that in future contests the students should be asked to follow an outline in writing their reasons; however, we realized the extreme difficulty in arriving at an agreement as to what form this outline should take. Your committee therefore suggested that the instructors should encourage their students to limit their reasons to the more important points in judging dairy cattle, and to make the reasons comparative rather than descriptive. In the contest we have just held, the students were provided with a single sheet of paper on which to write the reasons for each group of four animals.

The rules for 1916 were further modified so as to make addi-

tional deductions for incorrectly placing a class of animals in which two animals were widely separated. The rules for 1914 provided that the student should be cut 5 to 10 points for switching a close pair. In the 1916 contest we went one step further, and provided that additional cuts should be made for incorrectly placing a class of animals in which there is considerable variation. In order to avoid unnecessary complications we now make no distinction between close and very close pairs.

We have now traced the development of the judging contest in its various phases from the year it was first established to the present time. Whereas the first contest was a competition between nine teams, at which five trophies and a sweepstakes prize of $50 were offered, the 1916 contest was a competition between 18 teams, at which 7 team trophies, 5 gold medals, and $1600 in scholarship money was offered.

In the 1914 contest it became apparent to the management of the contest that there is a practical limit to the number of teams which can be handled without interference with the opportunity of the individual students to see and examine the animals. With 16 teams in the contest there is considerable difficulty in giving each student proper opportunity.

This fact was again demonstrated with the 18 teams in the 1916 contest. In the 1916 contest more than one-third of the agricultural colleges participated. With the growing interest in dairy-cattle judging, it was thought that in the near future several of the secondary schools would apply for participation in the contest. In order to prevent the contest from becoming unwieldy, it was decided to amend the eligibility clause for future contests to read as follows:

ELIGIBILITY OF CONTESTANTS

Any student of an agricultural college, who is regularly matriculated in a four-years course in agriculture or dairying, and has taken not less than twelve weeks undergraduate work in that institution during the calendar year in which the show is held, who has never taken part in any dairy-cattle judging contest of

a national or international character, nor in more than one intercollegiate contest, and that within the same calendar year, who has never acted as an official judge of cattle at a fair or show, and who has at no time served in the capacity of a teacher of animal husbandry or dairy husbandry in an agricultural college or secondary school, may enter as a member of a team to represent the college in which he is matriculated.

Immediately preceding the 1916 contest, the question arose as to whether or not the teams which had participated in the dairy-cattle judging contest at Waterloo, Iowa, were eligible, under the rules then in force, to participate in the national contest at the dairy show. At a meeting of the coaches held on the evening of October 12, it was decided that those students were eligible for the national contest.

An exhaustive analysis has been made of the 1916 contest, embracing a study of the system used in rating the students on written reasons, and of the different methods used in all past contests for determining the contest placing as compared with the official dairy-show placing. This analysis will be placed in the hands of the colleges which have participated in the contest, together with an outline of a proposed modification of the system for computing the ratings.

REPORT OF COMMITTEE ON INTERNATIONAL DAIRY CONGRESS

PRESENTED AT THE ANNUAL MEETING AT SPRINGFIELD, MASSACHUSETTS, OCTOBER 17, 1916

Committee: Fred Rasmussen, *Chairman;* B. H. Rawl, R. S. Breed, O. F. Hunziker, M. Mortensen

At the meeting of this Association held October 27, 1914, Prof. O. F. Hunziker, former Chairman of the Committee on International Dairy Congress, made a report to this Association. Information was presented relating to the proper procedure for securing the Congress for the United States. Report of joint meetings of the Committee and the National Dairy Council was presented. Efforts were made to obtain the financial and moral support of the various National dairy associations which met with failure.

Since the report of this Committee, the Sixth International Dairy Congress has been held in Berne, Switzerland. At this Congress there were over 1000 delegates present, coming from all parts of the world. It was considered the most successful Congress ever held. This great country, in which the value of the dairy products exceed $800,000,000 yearly, had one official delegate, sent by the State of New York. To members of this Association, it is needless to go into detail in regard to the great advantage to the teachers and scientists of attending this Congress, also the great advantage it would be to the dairy interests of this country to have the Congress held in United States.

The Seventh International Dairy Congress was to have been held in Denmark in 1917, but owing to the world war, the time for holding the Congress has been indefinitely postponed. It is, therefore, impossible at this time to make efforts to get the Congress to this country at a definite time.

Back of this International Dairy Congress is The International Dairy Federation. In 1903, when this Federation

was formed, Major Alvord was appointed a member of the Permanent Bureau of the International Dairy Federation. Soon afterward he appointed a committee of sixteen members to represent the dairy interests of United States. The membership of this Committee has not been kept up to a working basis. Your Committee, therefore, recommends that this Association request the present member of the Permanent Bureau for the United States, Chief B. H. Rawl, to revive the Committee of the International Dairy Federation with a view to creating an organization and sentiment for getting the International Dairy Congress to the United States and to get the support of the United States Congress so that the invitations to the International Dairy Congress will be sent through diplomatic channels, thus giving the Congress the same official standing it has had in all other countries.

REPORT OF COMMITTEE ON THE USE OF ALKALIES IN BUTTERMAKING

PRESENTED AT THE ANNUAL MEETING AT CHICAGO, ILLINOIS, OCTOBER, 1912

Committee: J. H. Frandsen, *Chairman*, M. Mortensen, Geo. Hines, F. W. Bouska

That your committee might quickly gather as much preliminary information as possible regarding "The Use of Alkalies in Buttermaking" a question blank was prepared by the Chairman and sent to many of the leading dairymen in College and practical work. The principal questions asked were substantially as follows:

1. What do you consider the principal reasons for the use of alkalies?

2. (a) What alkalies do you find most commonly used by the creameries in your State?

(b) If alkalies are to be used by the creameries, which would you consider most desirable? Why?

3. To what extent do you believe alkalies are now used in the creameries?

4. To what extent do you believe it possible to improve the quality of the butter from bad cream by the use of alkali?

(a) To what extent is the producer benefited or injured by this practice?

(b) To what extent is the manufacturer benefited or injured by this practice?

(c) To what extent is the consumer benefited or injured by this practice?

5. To what extent do you believe the healthfulness or wholesomeness of butter to be affected?

Please give any physical, chemical or bacteriological data that you may have available showing difference in butter made from cream to which alkali has been added.

6. Do you consider the practice of adding alkalies of any kind to the cream as injurious to the health of the consumer?

7. What do you consider would be the moral effect of permitting the general use of alkali in buttermaking?

Briefly summarizing the following answers were given to the questions asked:

1. What do you consider the principal reasons for the use of alkalies?

Answer: When sour cream is used!

(1) "For sake of uniformity of products." (2) "To develop a better flavor." (3) "To reduce acidity." (4) "To eliminate the characteristic scorch-flavor produced by pasteurizing sour cream." (5) "Prevent heavy loss of butter-fat in buttermilk." (6) "To improve flavor and keeping qualities of butter made from sour cream." (7) "To make possible the pasteurization of high acid cream without the metallic or scorched flavors."

2. (a) What alkalies do you find most commonly used by the creameries of your State?

Answer: (1) Lime (from every report). (2) Soda (reported by one). (3) Lime and sugar.

(b) If alkalies are to be used by the creameries which would you consider most desirable? Why?

Answer: (1) "Lime—because least objectionable to consuming public." (2) "Lime—because used in such small quantities it would not be injurious to the health of consumer." (3) "Lime—because less soluble in water, and less apt to remain in finished product." (4) "Free from undesirable flavors or odors." (5) "Lime—because it is cheap." (6) "Natural constituent of milk ash."

3. To what extent do you believe alkalies are now used in the creameries?

Answer: (1) "Nearly every creamery doing a shipping business and in some local creameries." (2) "In practically all centralizers." (3) (In Oregon) probably 10 per cent or more—while many creamerymen know nothing of the process." (4) "Do not know." (5) "Used by large creameries but not by small coöperative creameries" (Indiana). (6) "Cannot say—but perhaps by but few creameries in the State" (Iowa).

4. To what extent do you believe it possible to improve the quality of butter from bad cream by the use of alkali?

Answer: (1) "When used in combination with proper methods of pasteurization and with starter the quality of butter may improve 4 or 5 points." (2) "If really poor cream is used quality may improve from 1 to 3 per cent. In clean flavored cream—no improvement." (3) "Two points." (4) "Don't know." (5) "At least one grade."

(6) "One to three points—the latter only in case of storage." (Just the reverse.)

4. (a) To what extent is the producer benefited or injured by this practice?

Answer: (1) "Producer allowed to give cream less care." (2) "Benefited to extent that buttermaker takes cream that otherwise would have to be rejected. Injured by being led to believe no particular attention need be paid to care of cream." (3) "Producer not benefited." (4) "Some coöperative creameries are not compelled to use it and it must be a drawback to producer because he will not realize the importance of caring for his cream." (5) "Not benefited—but induced to employ shiftless methods a little longer." (6) "Benefited slightly by price paid for fat (1 cent per pound)." (7) "Indirectly injured because cream may get too old so as to sell 2 cents per pound less." (8) "Producer of low grade cream and small producer with poor market facilities benefited to extent of 2 cents per pound at expense of high producer with good market."

(b) To what extent is manufacturer benefited or injured?

Answer: (1) "Benefited by being able to produce a fair piece of butter out of old cream. Injured because it (a) militates against a good cream, (b) holds down prices, (c) retards Dairy development, (d) aids sale of butter substitutes. Injury greater than benefit." (2) "Manufacturer injured morally, benefited financially." (3) "Benefited by improving quality of butter—less cost of neutralization." (4) "Benefited by being able to make first grade butter from second grade cream."

4. (c) To what extent is consumer benefited or injured by this practice?

Answer: (1) "Consumer will be able to get only medium quality as strictly first class butter can not be made. He will be financially benefited because he will have to depend more on substitutes which are less expensive." (2) "Consumer not benefited." (3) "Neither benefited nor injured." (4) "No harm comes from neutralizer itself but it is the means of covering up filthy practices."

5. To what extent do you believe the healthfulness or wholesomeness of butter will be affected?

Answer: (1) "No effect from alkali but effect from toxic ferments in poor cream probable." (2) "No effect from alkali." (3) "No effect from alkali known." (4) "Very little if any." (5) "No direct result but only medium quality butter can be produced." (6) "Lime per-

mits higher temperature of pasteurization hence more killed germs—a better flavor, and but slight trace of lime found by chemist." (7) "None by neutralizer."

6. Do you consider the practice of adding alkalies of any kind to the cream as injurious to the health of the consumer?

Answer: (1) "No, not with lime anyway." (2) "No, except from condition of cream which made the use of alkali necessary." (3) "No" (no data available). (4) "Might be injurious, especially for buttermilk." (5) "Not with lime but would be if harmful alkali is used." (6) "Only indirectly."

7. What do you consider the moral effect of permitting the general use of alkali in buttermaking?

Answer: (1) "The same, but in less degree, as the sale of renovated butter as creamery butter." (2) "Economic result would be a failure to have cream quality raised." (3) "Bad, but justifiable as a temporary expedient." (4) "Tendency to encourage lax methods, and arouse suspicion of the consumer." (5) "Make producer less careful and make less really first class butter."

To the question asking for available physical, chemical and bacteriological data the universal answer was "no data available."

Because practically all seemed to realize that there was practically no actual data of any importance on this subject, it was thought best to inaugurate at least such work as would give us some general information on this subject. Accordingly about twenty experiments were started in our laboratory. Some of the butter was made from good cream, some from cream only fair, and some from cream about as bad as ever greased the vats of the poorest centralized plant. Each batch of cream was divided into 2, 3 or 4 parts. Part of the cream was churned raw, part was neutralized to about 0.3 per cent acid before being pasteurized. The different batches of cream were carefully scored by the assistants of the dairy department and by the writer. Some of the butter from unneutralized cream scored practically as high as that made from the treated cream. This was particularly true in the cases where the cream was of good flavor and not very sour. However in the most of the butter made from the very sour, bad flavored cream the score was

nearly always from 2 to 5 points higher than that of the butter made from the untreated cream.

Regarding the texture of the butter, the writer could not note any particular difference except in one or two cases where the cream had been treated with alkali to a point where it was practically neutral in its reaction. In this case the butter showed a very poor body and texture and was distinctly greasy. These samples also had a slightly bitter flavor.

CHEMICAL RESULTS

Chemical analyses were made of each sample of butter with a view of ascertaining any possible difference in chemical composition. The chemical analysis showed considerable variation and no particular importance can be attached to the few preliminary results available at this time except as a general indication of certain tendencies.

The average amount of calcium oxide found in the butter made from the treated cream was 0.075 per cent. Practically all the samples of butter made from the untreated cream showed a calcium oxide content of about 0.032 per cent. There were however some exceptions as a few of the samples from untreated cream gave calcium oxide percentage as high as 0.07 per cent. It should be noted here that these particular samples ran exceedingly high in casein.

Professor Bouska, a member of this committee, with the assistance of J. C. Brown, has done much work along this line. They give the following figures as results of their recent work.

	CASEIN	LIME
1. Raw, very sour cream, no lime added	1.18	0.065
2. Country butter	1.31	0.004
3. Country butter	1.60	0.112
4. Country butter	1.00	0.053
5. Moderately sour, slightly neutralized with lime	0.69	0.068
6. Moderately sour, slightly neutralized with lime	1.24	0.065
7. Very sour, neutralized with lime	0.95	0.067
8. Very sour, excessively neutralized with lime	1.16	0.126

The following analytical work was reported from Cornell University last summer:

CaO *in butter*

	per cent
Sample 1 (lime neutralized)	0.10
Sample 2 (lime neutralized)	0.68
Sample 3 (lime neutralized)	0.092
Sample 4 (Na neutralized)	0.087
Sample 5 (Na neutralized)	0.079
Sample 6 (Na neutralized)	0.065
Sample 7	0.044
Sample 8 (Na neutralized)	0.10
Sample 9 (without any)	0.076
Sample 10 (lime neutralized)	0.09
Sample 11 (lime neutralized)	0.087

BACTERIOLOGICAL DATA

From the bacteriological analysis submitted by Professor F. W. Bouska, the following data has been taken at random, covering a number of analyses of raw cream, pastuerized cream, and butter.

XI. (1) Raw cream

Molds	12,700
Liquefiers	500,000
Acid producers	300,000,000
Total	300,512,700

A composite sample of 9200 pounds of cream having an acidity of 27° testing 33 per cent butterfat. It was neutralized to 11° with 58½ pounds of milk of lime.

XI. (2) Pasteurized cream

Molds	0
Liquefiers	2,500
Acid producers	70,000
Total	72,500

Cream XI (1) after being pasteurized at 182 to 186° in a Farrington Pasteurizer, 9 per cent starter was added.

	per cent
Efficiency of pasteurization	99.976
Molds killed	100.0
Liquefiers killed	99.50
Acid producers killed	99.977

I. (1) Raw cream

Raw cream sample taken from vat containing 900 gallons = 7200 pounds. Neutralized to 0° acid by adding 78¾ of milk of lime. Cream contained 29.05 per cent butter fat.

Molds	27,000
Liquefiers	600,000
Acid producers	500,000,000
Total	500,627,000

I. (2) Pasteurized cream

Molds	0
Liquefiers	700
Acid producers	195,000
Total	195,700

Cream I was pasteurized at 180° F. by being heated successively in a fore warmer, cooler (with hot water) two pasteurizers, and cooled on a cooler and in cream vats. 5 per cent starter was used and ripened to 34° acid. 5 per cent of sweet raw cream was also added.

	per cent
Efficiency of pasteurization	99.96
Molds killed	100.
Liquefiers killed	99.89
Acid producers killed	99.96

I. (3) Butter

Molds	0
Liquefiers	0
Acid producers	2,000,000
Total	2,000,000

To compare with the cream data, which are volumetric, the butter analyses were made by means of a pipette, A1 cc. pipette delivered 0.9147 gram of butter. When a planting of 0.01 cc. did not reveal any liquefiers, 1 cc. and 0.5 cc. were planted. The results showed no liquefiers whatever. The cream from I (2) yielded 2876 pounds of butter.

IX. Butter raw

Odium lactis	48,000
Molds	100
Liquefiers	8
Acid producers	310,000
Total	358,108

A 20 pounds tub of whole milk butter two weeks old. From Strawberry Point.

Method

Sampling was done in such a way as to obtain a composite sample.

Numbering. The Roman numbers denote the series from the same cream, The Arabic numbers show the product of the series, e.g., I (1) is raw cream; I (2) is pasteurized cream; I (3) is butter.

Bacteriological technique. 1 cc. of the material was taken and 100 cc. waterblanks containing broken glass were used. The molds, oidium, and lactic acid were counted as whey agar plates. The liquefiers were determined on sugar free gelatin. The results for butter were given per cc. so as to compare with the cream; they can be changed to grams by dividing by 0.9147 and multiplying by 10,000. A cubic centimeter of melted butter weighed 0.9147 grams.

BACTERIOLOGICAL CONCLUSIONS

In my estimation the bacteriological data here submitted would at least indicate that after cream has been as thoroughly pasteurized, as is the case in most of the larger plants, that there is but little danger of undesirable bacteria being present to any appreciable extent in the manufactured butter. Whether certain toxic products might be present or not no one seems as yet to know.

CHEMICAL CONCLUSIONS

From the meager chemical data at hand it does not seem fair to say that the use of lime has in any way injured the butter or made it detrimental to health. About the only important difference noticed in most of the chemical data is a slight tendency toward a higher calcium content in butter made from neutralized cream. (In this connection it should be understood that all my experimental work has had to do with cream neutralized with lime. Thus far my time has not permitted of any experiments in the use of bicarbonate of soda—or soda ash.)

All the experts consulted by your committee practically agree

that the use of a neutralizing substance makes it possible to handle the cream efficiently and profitably, without heavy loss in the buttermilk, and also that the quality of the butter made from carefully neutralized and pasteurized cream will score from one to 5 points higher than butter made from sour, old cream, not neutralized.

Of peculiar interest in this connection is an article on "Calcium salts as Body Builders" by Rudolph Emmerick and Oskar Loew, two noted German Scientists. The researches of these men indicate that most of our foods do not contain enough lime. The investigators cite instances in Europe and America where natives of limestone regions are better developed physically. In conclusion these scientists even suggest that a teaspoonful of a lime solution be taken with each meal. Most of us are quite familiar with the common practice of physicians recommending the use of lime water for infants. The amount of lime given the baby in one feeding of milk is considerable larger than the amount found in several pounds of butter. These facts are only mentioned in support of the contention that the use of lime in the cream could not possibly be injurious to the consumer of the butter.

Mr. Alvord, the late chief of the Dairy Division (in Year Book U. S. Dept. of Agriculture, 1900) says in speaking of the great Western states that

> "They have an irregular, scanty rainfall. Long periods of drouth and hot winds are not uncommon. There are not here the woods, the great cool streams and the luxuriant grasses of the East. This country was considered fit only for grazing; farming seemed impossible; and dairying was out of the question."

The farmer here on the new and cheaper lands began slowly to compete along various lines with the farmer on the more high priced lands in the older dairy sections of the East. He gradually discovered that due to the low cost of the land, its uncropped fertility, that he could produce butter fat cheaper than his eastern brethern. The profits from wheat and other cereals however were generally so tempting that but few farmers saw their way clear to embark to any considerable extent in dairying.

Local creameries, such as he saw prospering in the thickly settled dairy sections of the eastern states were quite out of the question for a community where less than five cows to the square mile was the rule rather than the exception. Under such conditions it is quite evident that much ground has to be covered in assembling enough butterfat to operate a creamery in the thinly settled districts of Kansas, Nebraska or Colorado. Some idea of the seriousness of this problem can be noted from the statistics regarding the number of cows per square mile. From this table it will be seen that New York has something over 30.4 cows per square mile, Wisconsin, 26.83; Iowa, 24.86; Nebraska, 7.9; Kansas, 8.5; South Dakota, 4.71; and Colorado, 1.6.

No one who understands conditions on the Plains will believe that what is being done in intensive dairy sections of the east can be hoped for in the sparsely settled sections of the west for years and years to come. This country is not as a rule the home of the specific dairyman, but rather the general farmer; the man interested in large farms; in wheat raising and stock raising, and dairying, at least to start with, as a side issue. In time this type of farmer will realize more and more the importance of the proper care of the milk and cream on the farm, though as yet he feels unable to give the proper attention to this branch of his operations. As a result much of the cream produced under these conditions is very sour. Those of you familiar with the average western farm conditions will agree that in most cases this cream is bad because of the poor care, or rather lack of care, given it on the farm.

The use of lime or other alkalies was undoubtedly resorted to in order to make it possible for the creamery to so handle the poorer grades of cream as to be able to produce a grade of butter that would be decidedly better than any butter that could be made without such treatment. This generally means that the cream producer will get a market and a price not otherwise open to him. The use of lime or other alkalies are not in any sense a cure-all for all the vices and sins of the producer or the poor creamery men, and certainly its use should not be permitted to the extent of stopping or discouraging any practical or consistent

plan for real improvement made under dairy conditions. Ultimately the success of the dairy business depends in getting the farmer to produce a perfectly pure and sanitary article.

In going over the bad cream problem with the managers of some of our larger plants, I have with few exceptions, found them intensely interested in any practical scheme for raising the grade of cream received from the farm. Contrary to the views of some, I do not believe in any law preventing the shipping of certain grades of cream. Many new and fully as difficult problems would follow in the wake of such a law. The cream would likely still be produced on the farm and would not be wasted, as the farmer likely would return to farm buttermaking. In other words those farmers who ship bad cream would more than likely churn this into bad butter. Without more than the average care exercised on the ordinary farm, the chances are that the butter produced there would be decidedly worse than the butter made from the same cream in modern creameries. On account of its lack of uniformity it would undoubtedly sell as packing stock at very low prices. In my opinion, whenever we have worked out a practical and satisfactory scheme for the grading of cream, and when such a system is followed up by the creameries with a common sense plan of recognizing the difference in grades with a substantial difference in price, much will have been done towards interesting the farmer in the production of a better grade of cream. When this condition is reached there will be no need of using lime or even discussing this problem.

It would seem however that while this matter is being worked out, as it must ultimately be, that the creameries should be aided and encouraged in every possible way in producing the most wholesome article possible from the raw products at hand. As a member of the committee expressed it—"Logically dirt should be kept out of milk. It is however common practice to remove it by straining or centrifuge. Milk and cream should be produced germ free, but in practice the excessive number of bacteria are reduced by pasteurization. To reduce the acid, the product of bacteria, by neutralizing is also not ideal, but practically analogous."

The majority of this cream when its acidity is properly reduced makes at least a fair butter, which seems to satisfy the trade. If under present conditions this method of treatment was not permitted it would mean the impossibility of making, profitably, millions of pounds of butter and would shut off the dairy revenue of countless thousands of western farmers.

OPEN FORUM

What is Dairy Temperament?

In the judging of dairy cattle the term "dairy temperament" is used a great deal. I feel quite sure that the term does not always convey the same meaning, and many times the term expresses no definite meaning at all.

At the last National Dairy Show, a number of the dairy instructors comprising the coaches of the judging teams called together by Professor Van Norman, had much discussion on the various factors considered in judging a dairy cow. It was really a surprise what a difference of opinion existed as to just what was included under the term dairy temperament. Some included the nervous condition, others would have it mean "dairy tendency," others suggested that it meant "ability to change feeds into dairy products." Some thought that if such a meaning was attached to the term, then the whole form of the cow as it relates to milk production would be included. The final discussion simmered down to this, that by dairy temperament we mean, "that something almost indescribable in a cow, that seemed to exist in every large producing cow." Dairy temperament is similar to the general expression of an individual. We can tell there is a difference in the facial expressions of different people, but it is difficult to tell exactly what is the difference. Similarly there is a bodily expression in a dairy cow that correlates with milk production, which may be called "dairy temperament."

It has always seemed to me that to use terms in teaching, the meaning of which is not entirely clear, or to use terms in connection with judging that overlap, or to use terms that do not mean the same to different teachers, or that have no real definite meaning, is unsatisfactory.

I think that most judges of dairy cattle construe dairy temperament to mean dairy tendency or ability to change feeds into dairy products. Under this definition the whole mammary system would have to be included, also the poise, the carriage or the nervous temperament of the animal.

For a number of years I have given much thought to framing a score card that will enable both students and instructors to work understandingly and that will give the proper rating.

Among the different dairy cattle score cards I have used, the following has given the best results. I do not offer this as an ideal score card, but I would like to hear from the readers interested whether "dairy temperament" has been properly taken care of. In order to show the place assigned to dairy temperament it is necessary to give the full score card.

Date....., 191 .

SOUTH DAKOTA STATE COLLEGE
DEPARTMENT OF DAIRY HUSBANDRY
Students Score Card
Dairy Cattle

Name.....

SCORE OF POINTS	SCORE		
	Female		
	Perfect score	Students score	Corrected score
I. ABILITY TO CONSUME AND DIGEST FEEDS (capacious and efficient digestive organs) (20 points)			
Chiefly indicated by:			
1. Deep, wide and medium long barrel, ribs broad and wide apart, broad, long, and not too sloping loins.....	12		
2. Large, wide mouth, not peaked.....	1		
3. Loose, mellow, medium thick skin, yellow secretion, hair soft and fine.....	7		
II. ABILITY TO CHANGE FEEDS INTO DAIRY PRODUCTS (dairy temperament) (50 points)			
Chiefly indicated by:			
1. Udder capacity (30 points)			
(a) Front udder extending well forward and under abdomen.....	7		
(b) Hind udder extending back and high up between flat thighs.....	7		
(c) Udder not fleshy.....	2		
(d) Udder should be wide and level underneath and four symmetrically placed teats of good size.....	4		
(e) Thighs should be flat and wide apart, giving a roomy twist.....	2		
(f) Cow should be level over hips, rump, and pinbones, and have a long, wide rump...	8		

Students Score Card—Continued.

SCORE OF POINTS	SCORE		
	Female		
	Perfect score	Students score	Corrected score
2. Blood circulation (10 points)			
(a) Large, branching, crooked and long mammary veins	6		
(b) Large and numerous milk wells	3		
(c) Long, wide spreading and well-defined escutcheon or milk mirror	1		
3. Poise (10 points)			
(a) Wide forehead, not too heavy and coarse in throat-latch and jaw bone	2		
(b) Lean, healthy, refined feminine appearance, bright eyes, well carried ears and good body carriage	5		
(c) Prominent, straight, open-jointed back bone, reasonably straight at tailsetting	3		
III. Ability to Maintain Life and Health (constitution) (15 points)			
Chiefly indicated by:			
1. Deep and wide chest and spare shoulders	6		
2. Large nostrils, prominent windpipe	2		
3. Full and large heart girth, full in foreflank, full in crops and back of shoulders	6		
4. Large navel	1		
IV. General Form (15 points) including breed characteristics			
Chiefly indicated by:			
1. Size	6		
2. Color	2		
3. Symmetry	7		
Total	100		

C. Larsen.

Brookings, South Dakota.

Teaching Dairy Cattle Judging

Dairy instructors are at times censured and often, perhaps, justly on account of the methods used and the results obtained in the teaching of dairy judging. Instructors may have been open to censure and may, at times, have had meager success in developing their students into competent judges, partly at least, because we have adhered too closely to the breed score cards under the delusion that these score cards are based on known facts.

On the other hand, dairy instructors have been unjustly criticized by some followers of the show circuit who have forgotten that the chief function of any dairy cow is production, including both milk and calves.

The breed score cards have for many years been the chief reliance of the dairy instructors in their judging work. However, these score cards have never been entirely satisfactory.

First, most of the breed score cards, are in such detail that the student's mind is confused. To be comprehensive, much of the detail must be eliminated.

Second, the breed score cards have emphasized points that are not founded on known facts. Who knows for sure that the best kind of milk veins are long and crooked, or that the escutcheon should be broad, or that the tail bone should reach the hook, or that the udder should be level on the sole, or the excretions of the skin yellow? In other words, we have been teaching things that we do not know to be true.

Third, the breed score cards have not always emphasized the fact that the chief function of the dairy cow is production—the making of milk and the raising of calves. The breed score cards have taken up the points of the cow systematically, beginning at the head and working backward, without pointing out the relationship between these points and the functions of the cow which make for production. A student using such a card could hardly be criticized if he failed to associate the various detailed points with the main idea of production.

Some years ago the writer formulated a scale of points substantially the same as the one printed herewith. This scale of points in more or less modified form is now in use in several agricultural colleges in the United States. In preparing it, the aim has been to point out the relation between the appearance of the cow and her various functions which are essential to production and at the same time to avoid too much detail.

THE UNIVERSITY OF NEBRASKA DEPARTMENT OF DAIRY HUSBANDRY

SCALE OF POINTS FOR DAIRY COWS

What is desired in the Dairy Cow is heavy and persistent producing ability combined with good breed type. The milk secreting system, dairy temperament, constitutional strength and vigor, and capacity for handling feed are the main indications of producing ability.

1. *Points Indicating Efficiency of Milk Secreting System—Forty per cent.*
   Udder—Large, evenly quartered, well held up, not meaty, attachments long, teats squarely placed and of convenient size for milking..... 30
   Faults—Udder pendulous, loosely attached to body, attachments short, substance of udder meaty or lumpy, quarters of udder uneven, teats too small, too large, or unevenly placed.
   Milk Veins—Capacious, branching, entering large or numerous wells..... 10
   Faults—Wells and veins small, veins varicose, veins large with small wells.

2. *Points Indicating Dairy Temperament—Twenty-five per cent.* Body wedge-shaped. General appearance feminine, angular and lean, yet clean cut in every part, together with good quality..... 25
   Faults—Undue fleshiness, coarseness, or lack of symmetry or femininity.

3. *Points Indicating Constitutional Strength and Vigor—Fifteen per cent.*
   Nostril—Large, open expanded.....1
   Faults—Small nostril or one showing coarseness.
   Eye—Prominent, bright, mild intelligent.....1
   Faults—Sluggish, vicious, fiery, small or deep set.
   Chest—Wide, deep, roomy..... 3
   Faults—Chest narrow or shallow.
   General Build—Strong and rugged for breed, yet showing good quality. Pelvis long, roomy and level..... 5
   Faults—Undue refinement of bones, stunted appearance, badly drooping rump, weak back, pinched pin bones, lack of width through hips.
   Skin—Loose and mellow, showing good circulation and secretion..... 3
   Faults—Skin boardy, tight, papery. Hair harsh or staring.
   Carriage—Energetic, prompt, alert..... 2
   Faults—Unduly nervous or sluggish.

4. *Points Indicating Capacity for Handling Feed—Ten per cent.*
   Muzzle—Large but not coarse..... 1
   Faults—Muzzle pointed or narrow or extremely coarse.
   Jaw—Wide in angle, deep, strong..... 1
   Faults—Jaw light, narrow in angle, or lacking in depth.
   Barrel—Deep, wide, long, well held up, with ribs broad, long, far apart, slanting and well sprung..... 8
   Faults—Flank tucked up, slab sided appearance.

5. Points Indicating Breed Type—Ten per cent. Points characteristic of the particular breed, such as size, color, temperament, ruggedness of build, etc. 10

Faults—Markings, colors or size not typical of the breed.

Total 100

.....

Name .....

In this scale of points the fact that the value of the dairy cow is due mainly to her producing ability is kept constantly before the student. The main considerations in the judging of the cow are then taken up in the order of their importance.

There can be no doubt but that the development of the mammary system is the best single index now known as to the producing ability of a dairy cow, and on the score card forty points are accorded the indications of its efficiency. In going over the score card with students the points emphasized are size of udder coupled with good quality. This combination usually means a productive milk secreting system.

By dairy temperament we mean the ability of the cow to convert the food she eats into milk rather than into meat. This ability can best be judged by spareness and angularity of form coupled with evidences of thrifty condition.

The constitutional strength of a cow has commonly been judged almost entirely by the chest capacity. While the chest capacity is, perhaps, of some importance there are many other evidences of constitutional weakness, such as weak back or loin, pinched pelvis or poor nourishment of the skin.

Large capacity for handling feed in a cow is possibly not so essential to high production as it is to economy of production. It is possible that a cow of small barrel capacity if fed on a concentrated ration could supply her udder abundantly with nutrients for milk production. However, such production would not be economical. Roughages are as a rule much cheaper than the concentrates, so that the cow that can extract the largest proportion of the nutrients she requires from coarse feeds is the cow that will produce most economically.

If all dairy cows were judged by the same standard the breeds would tend to become more and more alike. There is no doubt but that the type that indicates heavy production in a Holstein cow will also indicate heavy production in a Jersey. However, the breeds are adapted to different climatic and topographical conditions on account of breed characteristics. Their milk fulfills different market conditions on

account of the different composition, so that it is essential that the characteristic type of the different breeds be kept separate. For this reason some weight on any scale of points should be attached to breed characteristics.

In using this scale of points in teaching judging a cow is brought into the pavilion and the meaning of the various items on the scale of points is explained in detail. After this the students are expected to remember the main points as well as their significance.

No cows are scored. Comparative judging is taught from the first. The students are given a placing card similar to the one printed herewith on which are listed the main divisions of the scale of points. The students rank the cows according to their merit in each division but do not score them. Filling out this card does much toward teaching the students to observe accurately. In the final placing the cow that goes first is, of course, not always the one that has been ranked first most times in the different divisions.

THE UNIVERSITY OF NEBRASKA DEPARTMENT OF DAIRY HUSBANDRY

PLACING CARD FOR DAIRY COWS

Always letter the cows A-B-C-D beginning at the right

MAIN POINTS	PER CENT	FIRST	SECOND	THIRD	FOURTH
Milk Secreting System	40				
Dairy Temperament	25				
Constitutional Strength and Vigor	15				
Capacity for Handling Feed	10				
Breed Type	10				

Placing.....

Class of Animals.....

Date.....Name.....

There are perhaps few subjects that have been taught in our agricultural colleges as long as Dairy Cattle Judging about which so little is definitely known. This will likely remain true for some time on account of the difficulty of investigating the process of milk secretion, though there is certainly need for good work to be done along this line.

E. G. WOODWARD.

Lincoln, Nebraska.

ABSTRACTS OF DAIRY LITERATURE

Studies in the Cost of Market Milk Production. A. C. ANDERSON AND F. T. RIDDELL. Bulletin 277, Michigan Agricultural Experiment Station.

The data presented in this bulletin covers a period of two years, from 1914 to 1916 and includes figures from twenty-five farms near Grand Rapids, Michigan. Most of the other figures secured on this point have been in New England or Atlantic Coast States. This data was secured by a one day visit to each farm monthly. All of the farms produced market milk, some of them being dairy farms solely, although most of them were coupled with grain, vegetables, live stock or fruit production, and each farm was conducted according to the ideas of the owner or operator.

The expenditures were as follows:

	1914	1915
Total number of farms	25	25
Average number of cows for year	459.46	428.57
Man Labor	$28.68	27.19
Hauling Milk and other horse labor including R. R. Transportation when necessary	15.54	14.77
Feeds		
Roughage	31.02	30.38
Concentrates	28.61	26.68
Pastures	8.36	7.66
Cash sundries	1.96	1.77
Veterinary services and drugs	.86	.99
Taxes, interest and depreciation on herd	9.88	9.49
Taxes, interest, insurance and depreciation on buildings	8.72	10.33
Depreciation on barn tools and dairy utensils	.50	.48
Actual losses from tuberculosis and other deaths	1.95	6.25
Added earning power of owner due to knowledge, experience and interest in excess of that possessed and used by ordinary labor	6.00	6.00
Added risk due to instability of market for product as whole milk, which in single year amounts to 30 per cent, and in one year out of every five years would be 6 per cent	8.47	8.30
Total	150.57	150.29

RECEIPTS

	1914	1915
Average pounds of milk produced	6,928.00 lbs.	7,156.8 lbs.
Gallons of milk produced	834.70 gal.	862.3 gal.
Average price per gallon delivered into Grand Rapids	16.90¢	16.35¢
Value of milk produced	$141.35	$139.01
Credit by manure	17.45	17.59
Total value of products per cow	158.80	156.60
Net profit per cow	8.23	6.31
Cost of production per gallon	15.90¢	15.39¢
Net profit per gallon	1.0¢	0.7c
Cost of production and delivery per hundred weight	$1.916	$1.854
Cost of production per quart	3.475	3.848

The authors bring in a new point, that of "instability of market for product as whole milk" which in a single year may amount to 30 per cent and occurs as they estimate, one year in five which would be 6 per cent of the total cost of production, in this case $8.47 for 1914 and $8.30 for 1915. Undoubtedly this is a risk to contend with, although it would probably vary somewhat in different localities. When one considers the chance of a siege of contagious abortion, or of some disease epidemic, being traced to the herd or dairy, these figures included by the authors seem none too high.

The investment expressed percentagely is as follows:

	per cent
Investment in cattle	45
Investment in buildings	54
Investment in equipment	1

For 1915 the distribution of cost factors were as follows, expressed percentagely.

	per cent
Grain	17.8
Roughage	20.2
Pasture	5.1
Hauling milk and horse labor	9.8
Man labor	18.1
Market losses	5.5
Taxes, interest, insurance and depreciation of buildings	6.9
Same on cows	6.3
Tuberculosis, etc	4.1
Management	4.0
Depreciation on tools and dairy utensils	0.3
Veterinary services	0.7
Cash items	1.2

The authors point out that during the last two years the cost of labor has increased 25 per cent, concentrated feeds 30 to 35 per cent, roughage 10 per cent and minor supplies and milk room equipment 25 to 60 per cent.—G. C. W.

Goats' Milk for Infant Feeding. W. H. JORDAN AND G. A. SMITH. Bulletin 249 of the New York Agricultural Experiment Station.

A herd of goats given the station were kept for a number of years, during which time, milk and feed records were carefully recorded. The feed was fed collectively but the milk was weighed individually.

During 1912, three adult males, twenty-eight females and nine kids, consumed the following feeds, the cost of which is figured at prevailing prices at that time.

FEED	DAYS FED	AMOUNT USED	COST PER 100 POUNDS	TOTAL COST
		pounds		
Grain	365	14,688	1.45	212.96
Bean pods	199	18,180	0.35	63.63
Beets, mangel	46	1,550	0.20	3.11
Hay mixed	273	19,500	0.50	97.80
Grass	122	24,300	0.15	36.45
Pasture	132			28.00
Total				441.95

The average cost of feed per quart was 4 cents in 1912 and for three years during which the record was kept, 3.4 cents. The lowest cost for any one goat was 1.27 cents a quart. The average of the Jersey herd during the same period was 0.92 cent per quart.

The period of lactation continues from 250 to 300 days and a good average yield is from 700 to 900 pounds of milk. One goat however proved exceptional, producing 1028.5 pounds of milk in 1910, 1845.2 pounds of milk in 1911, and 1391.1 pounds in 1912. This is the goat that produced a quart of milk for 1.27 cents for food cost (not based upon accurate individual record).

The mixed milk of the herd tested, averaged daily from 3.4 per cent to 4.4 per cent butter fat in May and June. For the same period the total solids were from 11.34 per cent to 12.91 per cent. In August 11 goats, 33 samples from which were taken averaged 3.82 per cent butter fat, 1.0294 specific gravity, 12.12 per cent total solids, 3.21 per cent total

protein, 2.40 per cent casein and 0.55 per cent ash. The variations in fat were from 1.8 per cent to 8.4 per cent. The average composition differs only slightly from milk from average cows.

It appeared from tests made that goats milk was slightly more satisfactory in producing gain with infants than cows milk, although the analysis and a complete chemical examination of the salts; does not offer a satisfactory reason. It did appear that the curds of goats milk, when returned from the stomach, were smaller and more flocculant than cows milk and there was evidence that the goats milk was more rapidly digested.—G. C. W.

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